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THE AMERICAN PACIFIC CABLE WAS OPENED on July 4 with a telegram from President Roosevelt at Oyster Bay, Long Island, to Governor Taft at Manila, P. I. The final connection of the cable was made between Midway Islands and Honolulu, Hawaii; the cable was landed and spliced at the latter point on July 4 after much trouble and delay, due to storms in that neighborhood. After this first message and Governor Taft's reply, a congratulatory message was sent by President Roosevelt, at Oyster Bay, to Mr. C. H. Mackay, President of the Pacific Cable Co., also at Oyster Bay, by cable and telegraph around the world. This message went by land wire to San Francisco, by the new cable to Manila (via Honolulu, Midway Islands and Guam), and by an older cable from Manila to Hong Kong; from the latter point foreign cables took the message via Indian points, Aden and Suez to the Azores, from where the Commercial Cable Co.'s lines took it to Canso and thence to New York. The time between transmission and receipt of the message at Oyster Bay was twelve minutes. A reply by Mr. Mackay sent over the same route in the reverse direction, took nine minutes.

THE PASSAIC VALLEY TRUNK SEWER PLANS may be proceeded with at the pleasure of the commissioners, The governor and attorney-general of New Jersey have certified that, in their belief, there is no ground for legal action against the project on the part of New York state. Mr. Julius A. Lebknecher, of Newark, N. J., is chairman of the commission. Thus far, it appears that no progress has been made further than to secure a preliminary report and an estimate, based on surveys, from Mr. Rudolph Hering, M. Am. Soc. C. E., of Hering & Fuller, New York city. The last session of the New Jersey legislature continued the commission, and authorized a bond issue for the prosecution of the work, but stipulated that no work should be done until the above-named certificate had been issued.

RAT CATCHING is an important branch of the work of the Board of Health of Manila, P. I. The object of this work is to suppress the ravages of the plague, which was held in check in 1902 but has been increasing this year. From a long account of the plague, and the relation of rats thereto, published in the New York "Medical Record" for July 4, it appears the Manila Board of Health employs about a hundred official rat catchers, who are paid a salary, and a bounty for each rat. There is also a bounty for rats brought in by others. The official rat catchers use some 2 000 traps, besides employing various other means, such as poison, cudgels, and sulphur blowers.

THE GERMAN MUNICIPAL EXHIBITION at Dresden opened on May 20, and will be continued until the end of September. It is limited to German municipalities of 25,000 population and upwards. The London "Surveyor" states that 128 towns, with an aggregate population of 13,000,000, are taking part.

MUNICIPAL OWNERSHIP OF THE STATEN ISLAND ferry system, New York City, is recommended in a report made by Mayor Low and Dock Commissioner Hawkes. The city would improve the facilities at the Manhattan and Staten Island terminals, and would build five new ferry boats, all at an estimated cost of $3,250,000. It would then lease the system to an operating company for five years. In support of the proposition the report states:

> We have already pointed out that, in the mere matter of the physical arrangement of the railroad tracks as they reach the ferry house, neither railroad has been animated, in the slightest degree, by a consideration of the island; each has thought only of its own interest as a competitor of the other railroad. So long as this ferry is operated by one railroad or the other, this spirit will dominate the operation of the ferry in every particular; and the railroad operating it will operate it primarily so as to get for itself the maximum of advantage. It goes without saying that Staten Island is entitled to a ferry that is operated in the interest of the island itself. The present ferry is run without loss. If the city will provide the boats as well as the terminals, a much better service than that of to-day can be given by an operating company without loss. If the city is prepared for a few years to carry a moderate loss, a much better service still can be given.
>
> For these reasons we propose that the city should not only own and improve all the terminals used for the Staten Island ferry, but also that it should itself cause to be built, and own, the boats to be used in the service. Only so can the Borough of Richmond secure the treatment to which it is entitled as an integral part of the city. When the city has a complete franchise and plant to offer there is no doubt that it can obtain much better service for the island without loss than can be obtained for it in any other way. If the city authorities of the time determine that the island ought to have better service than can be given without loss, they will then be in a position to command whatever quality of service they deem deem proper. In other words, the city itself would be in command of the situation.

UNIFORM MUNICIPAL ACCOUNTING in Massachusetts was provided for in a bill introduced in the legislature of the current year. After being reported, it was recommitted to the joint committee on cities, which finally referred it to the next session of the legislature, four members dissenting. The bill provided that hereafter the controller of county accounts should be known as the controller of county and municipal accounts, and that he should report to the next legislature a system of accounts to be kept by the several counties, cities and towns of the state. The auditor of each town and city would be required to report to the above-named controller annually, on blanks furnished by the latter, (1) a summary of all receipts, expenses, and uncollected dues; (2) appropriations and expenditures thereunder by departments and items; (3) expenditures for construction, for maintenance and operation, and for other purposes, also by departments; (4) construction and operating expenses, and income, on account of each municipally-owned public service industry; (5) a debt statement, "showing the purpose for which each item was created and the provisions made for the payment thereof." The controller of accounts was given authority, under the proposed act, to employ experts to assist him in formulating the system of accounts. It is to be hoped that the bill will be enacted next year.

EXAMINATIONS FOR DRAFTSMEN will be held at the Navy Yard, Washington, D. C., July 24 and 25. There are a number of vacancies now, but those who pass will be eligible for two years from the date of examination. The positions with their daily pay are as follows:

Structural Steel Work Draftsmen—	
1st class	$5.04
2d class	4.72
3d class	4.48
Assistant Structural Steel Work Draftsmen—	
1st class	$4.00
2d class	3.76
3d class	3.52

Candidates who do attain the percentage required for draftsmen will be eligible as assistant draftsmen, if their examination warrants it. Applications should be addressed to the "Commandant, Navy Yard, Washington, D. C."

ARBITRATION OF DIFFERENCES not settled by negotiation has been agreed upon by the large New York contracting firm known as the George A. Fuller Co. and certain unions of workmen. Under the agreement, either party may demand arbitration, in which case the company must select two representatives not officers, stockholders or employees of the company, and the unions must select two men not members thereof. These four shall choose an umpire. The decision of the five shall be binding on both parties and pending a decision neither a strike nor a lockout shall be declared. The company agrees to employ union men only, and to see that only such are employed by sub-contracts. The unions promise not to agree "to work for others in any line of work to the exclusion of the" company.

THE PROMOTERS OF THE ASPHALT TRUST are to be sued by the Receiver for the profits which they made in the organization of the Asphalt Company of America.

TWO TURBINE STEAMERS have recently been built in England for the channel service between England and France. These are the "Queen," for the Dover and Calais service of the London, Chatham & Southeastern Ry., and the "Brighton," for the Newhaven and Dieppe service of the London, Brighton & South Coast Ry. Both were built by Denny & Brothers, of Dumbarton. The "Queen" is 310 ft. long, 40 ft. beam and 25 ft. deep. It has two pole masts and two smokestacks fitted with the Denny spark arrester, so that the decks will not be covered with ashes, as is generally the case on steamers using forced draft. The boats are carried by a special quick-lowering gear, and the rather unusual practice is adopted of keeping them swung out ready for lowering during the voyage. They are only swung in when the steamer is coming alongside the dock or pier. The propelling machinery consists of three steam turbines of the Parsons type, each driving a separate shaft. When coming alongside the dock only the two side shafts are operated, so as to facilitate the landing of the vessel, the same as with a twin-screw steamer. The central turbine is high pressure, and revolves at 700 revolutions per minute. The other two are low pressure, and make 500 revolutions. The total ratio of expansion from the high-pressure turbine to the condensers is about 125 times. To provide for handling the vessel with two turbines, there is placed inside the exhaust end of one low-pressure turbine a reversed or "astern" turbine, controlled by slide valves operated by combined steam and hydraulic reversing engines. These valves admit live steam into the low-pressure or "astern" turbine respectively for going ahead or astern. The central turbine under these circumstances revolves idly in a vacuum, its steam admission valve being closed and its connection with the low-pressure turbines being shut off by non-return valves. Steam is supplied at 150 lbs. pressure by two double-ended and two single-ended Scotch boilers. The mean speed of two trips on a measured mile was 21.76 knots, the maximum speed (with the tide) being 22.25 knots. When going ahead at 20 knots the turbines were suddenly reversed to full speed astern and the vessel was stopped in 1 min. 7 secs. in 2½ times its length.

THE MOST SERIOUS RAILWAY ACCIDENT of the week, and by far the most serious one for a long time past, was a butting collision which occurred on the Southern Railway near Rockfish, Va., twenty miles southwest of Charlottesville, on July 7. A northbound freight train on the main track had been ordered to take a siding so as to allow a southbound through passenger train to pass, but failed to do so, with the result that the southbound train ran into it at full speed. The worst loss of life occurred in a second-class coach near the head of the train. In all more than twenty persons were killed.

ACCIDENTS ON ELECTRIC RAILWAYS have been quite numerous in the past few months. Two accidents during the past week were each responsible for several deaths. On July 4 a car of the Pittsburg Railways Co. in Pittsburg, Pa., was derailed on a bridge on Lincoln Ave. and fell to the street below, a drop of nearly one hundred feet. Of the five persons on the car one jumped in time, two were killed, and two fatally injured. On the same day a butting collision occurred on the Lockport & Olcott Electric Railway, a few miles north of Lockport, N. Y., between crowded cars. The running speed on this line is high, and the wreck resulted in the death of one person, and the probably fatal injury of half a dozen others.

A DAM FAILED AT OAKFORD PARK, near Jeannette, Pa., on Sunday, July 4, causing heavy damages to property and a loss of life variously estimated at from 50 to 75. Oakford Park is about 28 miles from Pittsburg, and is a pleasure resort owned by the Pittsburg Railway Co. The dam appears to have been an earth embankment some 40 ft. high, built to form a small lake. A heavy rainfall occurred late in the afternoon, during which many people took refuge in the car barns and in a restaurant building in the park. The failure of the dam is described as a small breach at the top, followed by a sudden giving way of practically the whole of one section of the dam. The damage extended for some distance down the valley. A bridge with a well-loaded trolley car gave way, and many or all the passengers were lost.

AN IMPROVED CENTRIFUGAL DREDGING PUMP.

By Capt. Mason M. Patrick.*

Two great problems which the Mississippi River presents for solution are the control of the floods and the betterment of the low-water channel. These questions have engaged the attention of eminent engineers, while many others, without laying claim to the possession of much engineering knowledge, have advocated what they often call "practical" plans, some of which are decidedly novel. One man would prevent floods by digging a canal "along the base of the Rocky Mountains," diverting the waters of the Missouri into the Rio Grande, or sending them through a separate channel into the Gulf; another, having learned of the existence of a water-bearing stratum some hundreds of feet below the bed of the Mississippi, gravely proposed to sink in the stream vertical pipes "of large size" reaching to this stratum, then when the river rose over the tops of the pipes, the flood waters would escape through them! Numerous plans, just as "practical" and quite as curious, have been proposed for improving the low water navigation.

The great majority of the engineers who have intelligently studied the mighty river, continue to indorse and advocate the levee system as the best means to control the floods. If the easily eroded banks of the river could be protected and permanently fixed at any reasonable cost, the difficult problem of permanently improving the low-water channel would be much simplified. So great would be the cost of doing this by any adequate known method, that, for the present, all thought of so doing has apparently been abandoned, and the Mississippi River Commission has definitely committed itself to a project for improving the low-water channel by dredging through the obstructing bars, each low water season. For this work there are employed powerful hydraulic dredges and the excavated material is deposited by means of floating pipes to one side of the channel, or in the deep pool below the bar. The improvement thus made is admitted to be but temporary; a number of dredges must be kept available for the work whenever the river falls to a low stage, and the average annual cost of maintaining and operating this dredge fleet will probably amount to not less than $400,000. This sum is, however, undoubtedly less than the interest on the amount which it would cost to permanently improve the low-water channel.

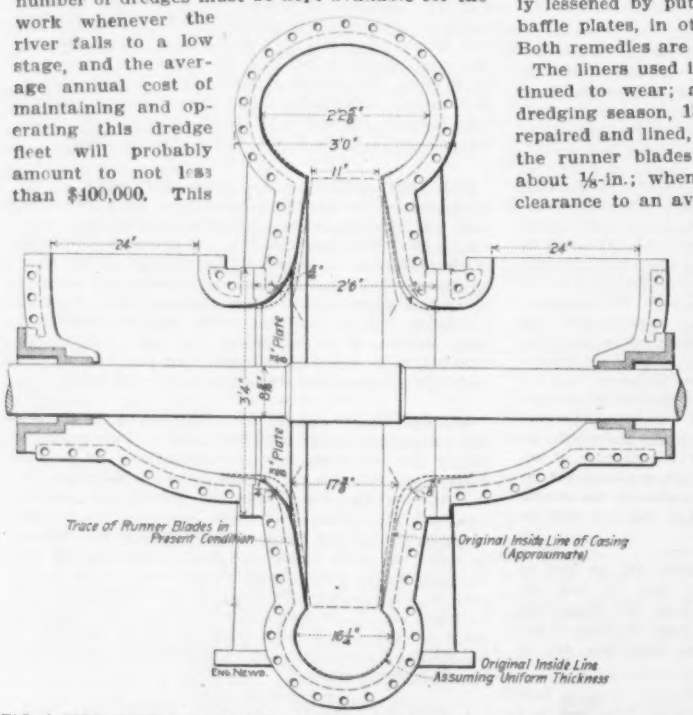


FIG. 1. TOP VIEW OF LOWER CASING OF MAIN PUMP ON U. S. DREDGE "EPSILON," SHOWING WORN CONDITION OF CASING.

The first hydraulic dredge built for this work, about ten years ago, was an experimental one, but its operation proved conclusively the practicability of this plan of thus opening and maintaining suitable channels at low stages of the river. This first dredge was followed by others which embodied changes and improvements suggested by experience. The centrifugal pump installed on the first dredge was purchased from a well-known maker; the pumps on the next six dredges were supplied by the contractors after their own designs or after designs prepared by makers of such pumps.

From time to time examinations were made of these pumps, and it was found that considerable wear was taking place; the casings and the runner blades were all wearing, but by no means uniformly. Especial attention was not called to this wear until the fall of 1898, when after a little more than 1,000 hours' dredging, it was found that a new pump casing of good cast iron, originally about 2 ins. thick, had been worn through; the edges of the runner blades had also been considerably worn.

Fig. 1* shows the wear in this pump and indicates how the casing was temporarily repaired. It will be noted that the greatest wear took place just inside the throat entrance, and opposite the inner points of the runner blades. The worn surface extended entirely around the casing. Other pumps, when examined, showed like wear, though not quite so great. Fig. 2* shows the character of the wear in another pump at the end of the season of 1899. In several of the pumps wear had taken place in the throat entrances (see Fig. 3), and the shafts also showed signs of wear. Fig. 4 shows a cross-section of a casing liner of cast iron after only 12 hours' actual dredging on a bar consisting mainly of heavy gravel. This is notable both for the great amount of the wear in so short a time, and for the grooved wear which it illustrates.

The first thing to be done was to repair the existing casings, and then devise expedients which would permit their use in spite of the wear to which they would be subjected. Liners, in some cases of cast iron, in others of boiler plate, were put in position, and spare sets of liners were kept on hand to replace those worn out, as occasion might require. The wear in the throats was greatly lessened by putting in position in some cases baffle plates, in other instances pieces of angles. Both remedies are shown in Fig. 5.

The liners used in the pump casing proper continued to wear; at the beginning of the next dredging season, 1899, after the pumps had been repaired and lined, the average clearance between the runner blades and the casings was made about ⅛-in.; when the wear had increased this clearance to an average of about 1½ ins., it was estimated from the gage readings, from the rapidity with which the dredge could be drawn into the cut and from the size of the stream of water pumped, that the efficiency of the pump had decreased about 50%. This conclusion indicated an additional reason for devising a type of pump in which the wear would be much less, or of finding a lining material which would better resist abrasion than those already tried.

As an experiment, rubber plates were attached to the blades, but while the indications at first were that they would answer the purpose, they did not stand the test of continued service, and were discarded. One result of this experiment is perhaps worthy of note; at first these rubber plates were attached to the blades by 1½ × ½-in. iron straps running across the blades, as shown in Fig. 6, with the result upon the casings as indicated in the same figure; opposite each end of each of the straps, a deep groove was worn in the casing indicating that the straps had been sufficient to divert the water-borne sand, and concentrate its action at the places where this grooved wear appeared. This drew attention to the fact, later further emphasized, that any projection on the blades which tended to so divert and direct the sand would result in similar wear. Attention is again invited to Fig. 1, and to the shape of the blades where the entering stream first impinges upon them; may not this shape account to some extent for the wear shown, the curved part of the blades serving to divert the abrading sand against that part of the casing which shows the greatest wear?

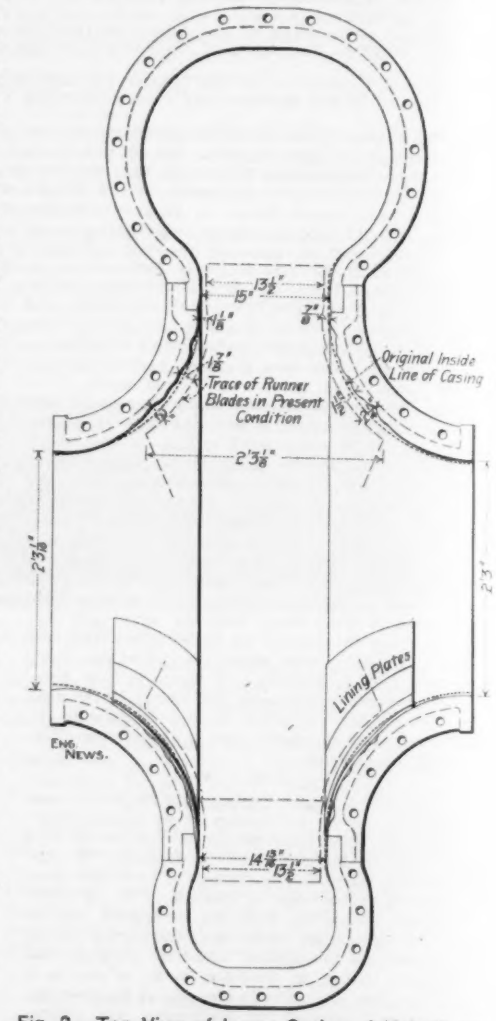


Fig. 2. Top View of Lower Casing of Main Pump on U. S. Dredge "Gamma," Showing Worn Condition of Casing.

In order to obtain an idea of the wearing qualities of different materials under the conditions existing in the pumps while dredging sand, a sand blast outfit being available, samples of some twenty different substances were subjected to the action of the sand blast, under conditions as nearly identical as possible, with the results as tabulated below for 14 of the samples. The results upon the other samples, which consisted of leather, mortar made of pure cement, or of cement with various proportions of sand, and of softer kinds of lumber, are not tabulated, as they were destroyed so rapidly that anything like an accurate determination of the losses of volume was not practicable. The samples had all the same size surface exposed to the sand blast, area 3 ins. × 3 ins.; the nozzle was held at the same inclination and at the same distance from all samples, the same kind of sand was used and the pressure was kept as nearly uniform as possible.

While these tests may not be conclusive, they furnished the best obtainable guide; and as a result boiler plate was used whenever practicable for the casing liners. Where cast liners had to be employed, they were ultimately made of cast iron containing a goodly percentage of scrap steel and cast against a chill.

While these experiments were in progress and

*Corps of Engineers, U. S. A., Washington, D. C.

*Copied from article by F. B. Maltby, U. S. Assistant Engineer, M. Am. Soc. C. E., published in Journal of the Association of Engineering Societies, May, 1900.

Table Showing Wear of Different Materials Under Action of a Sand Blast.

Material.	Weight—Before testing, grams.	Weight—After testing, grams.	Weight—Loss, grams.	Specific gravity.	Loss of volume, cu. cm.	Duration of test, mins.	Air pressure, lbs.	Loss of volume per min., cu. cm.
1. Boiler plate	544 00	537.60	6.40	7.85	0.815	4	18.5	0.204
2. Wrought iron	279.78	271.80	7.98	7.77	1.027	4	18	.257
3. Cast steel	521.64	513.68	7.96	7.85	1.014	4	18.5	.253
4. Copper	83.24	80.80	2.44	8.90	0.274	1	18	.274
5. Cast iron	458.56	446.68	11.88	7.21	1.648	4	18	.412
6. Sheet brass	37.60	33.48	4.12	8.40	0.490	1	18	.490
7. Bronze	215.16	195.16	20.00	8.50	2.353	4	18	.588
8. Soft rubber	104.52	98.36	6.16	0.93	6.624	4	19	1.656
9. Sheet lead	110 80	103.16	7.64	11.40	0.670	22/60	18	1.827
10. Yellow pine	96.52	82.60	13.92	0.72	19.333	2	10	9.667
11. White oak	115.40	95.76	19.64	0.77	25.506	2	17	12.753
12. Red oak	96.00	79.80	16.20	0.70	23.143	2	20	11.571
13. Elm	86.60	69.16	17.44	0.56	31.143	2	17	15.571
14. Sycamore	107.16	79.88	27.28	0.59	46.237	2	20	23.118

the various expedients were adopted for application to the existing pumps, the idea was not lost sight of that the best thing to do would be to design a pump upon which the wear would be reduced to a minimum; much time and study have been devoted to developing a design for a pump which will be best adapted to the service which will be required of it. The intermediate steps in the evolution of the final design were interesting, especially to those engaged in the solution of the problem; there were unexpected developments and some failures, but at last there has been evolved a design of pump upon which it is believed the wear will be reduced to a minimum and the evil

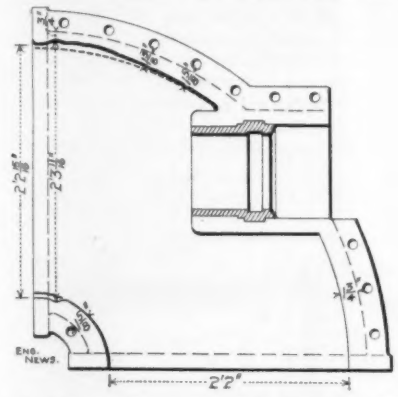


Fig. 3. Pump Elbow, Showing Wear in Throat Entrance.

effects of the wear that does take place will be easily counteracted.

This pump is shown in considerable detail in Fig. 7. This pump will be more costly to build, but it will pay for itself in the saving in the bills for repairs and in the greater efficiency due to the greatly decreased wear.

The runner is enclosed and is designed to be

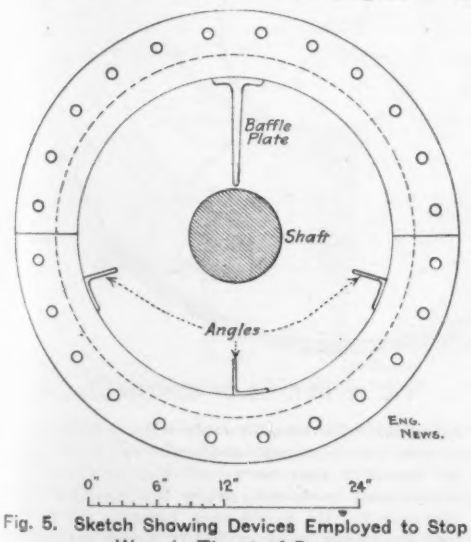


Fig. 5. Sketch Showing Devices Employed to Stop Wear in Throat of Pump.

cast in one piece; as experience has shown that on inclosed runner blades, the greatest wear takes place at the outer ends, provision was made to resist it here by the attached plates of car wheel iron cast against a chill. A ring of the same material is riveted to the runner while another ring, adjustable, is attached to the casing; the clearance between these two rings will be reduced to the minimum. The throat ring of cast iron, A, extends far enough into the pump to divert the entering dredged material between the inclosing plates of the runner; this ring is renewable and is held in place by the suction elbows, so that it can be readily put in position. The casing is lined throughout, but the inner surfaces of the sides of the casing are plane, so that the liners are easily attached, quickly renewed if they do wear out faster than is expected, and spare ones will be carried.

The credit for the design of the details of this pump is due to Mr. Thomas Middleton, Assistant Engineer, now with the Mississippi River Commission.

This pump will be installed on the dredge, now being built, under the direction of the writer, for use at South West Pass of the Mississippi River for dredging in the Pass between the proposed jetties. The pump will be directly connected to vertical triple-expansion engines, cylinders 21 ins., 32 ins., 54 ins., with 26 ins. stroke; the steam pressure at the boilers will be 170 lbs.; the pump will be run at an average speed of about 130 revolutions per minute, at which speed, it is expected, the engine will develop about 900 I. HP., and the the pump will handle the dredged material at the rate of about 2,500 cu. yds. per hour.

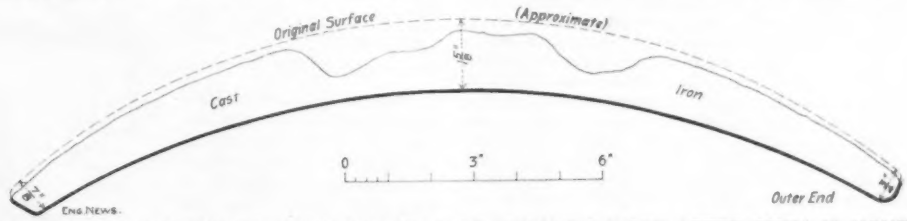


FIG. 4. CROSS-SECTION OF WORN CASING LINER, SHOWING WEAR AFTER ONLY 12 HOURS' DREDGING.

THE RECENT MISSISSIPPI RIVER FLOODS AND THEIR RELATION TO THE LEVEES.*

By T. G. Dabney.†

In comparing the flood of 1897 with that of 1903, it is apparent that the former was of much greater magnitude than the latter; that is to say, the volume of water that passed Cairo in 1903 was much less than that of 1897. This may be illustrated by pointing to the fact that in 1897 the river at Cairo remained above the 48-ft. stage 40 days, while in 1903 that period was only 18 days. The 50-ft. stage was exceeded in 1897 for 18 days, the corresponding period in 1903 being eight days only; and the maximum gage reading in 1897 was 51.6 ft., while in 1903 it was 50.6 ft., or 1 ft. lower.

Under the above state of facts as to Cairo, the maximum stage at Memphis this year exceeded that of 1897 by exactly 3 ft., and this excess was prevented from reaching a still higher elevation by the two large crevasses that occurred in the St. Francis levee two or three days before the culmination of the flood at Memphis.

The additional flood elevation that would have been reached at Memphis, had those crevasses not occurred, is, of course, matter of conjecture to a considerable extent; but it seems probable that about ½-ft. would have been added to the gage reading.

Assuming this to be true and adding another foot for the difference at Cairo between the former and the present year's flood elevation, the result will be not much below 42 ft. for the Memphis gage, with a flood volume equal to that of 1897; and with allowance for a longer continuance of the high water, and a still higher stage at Cairo, that figure may be reached, or perhaps somewhat exceeded, as the ultimate maximum gage reading at Memphis.

*Extracts from a manuscript report on the high water of 1903, made to the Mississippi River Commission.

†Chief Engineer, Yazoo-Mississippi Delta Levee District, Clarksdale, Miss.

It is a matter for regret from an educational standpoint alone that the breaks in the Arkansas levee occurred before the culmination of the flood at Memphis.

At Helena the highest gage reading was 51 ft., exceeding the Cairo maximum by 0.4 ft. The Helena record was again vitiated for educational purposes by the escape of flood water into the St. Francis basin, as has occurred in all former flood years; but that influence had much less effect this year than in any former high-water year, with perhaps 1898 excepted.

The excess of flood height at Memphis was not unexpected, though it somewhat exceeded my anticipations for the volume of water that passed Cairo.

It may be remarked that the relations between the Memphis gage, on the one hand, and those at Cairo and Helena, were rather consistent, Memphis falling 10.5 ft. below Cairo and 10.9 ft. below Helena. The difference as to Cairo would have been diminished by about ½-ft. had not the St. Francis crevasses occurred, from which it may be inferred that the ultimate relations between the Cairo and Memphis gages, when the entire flood volume shall be confined to the channel, should be about the same; that is to say, the Memphis maximum should continue to be about 10 ft. below the Cairo maximum.

The same cause that modified the Memphis maximum this year also modified the Helena maximum, so that no safe deduction can be made from these data as regards the ultimate relations of these two gages.

LESSONS OF THE FLOOD.

The following deductions are drawn from the experience of the 1903 high water: (1) The levee proper, that is, the body of the structure, showed no weakness, with trifling exceptions, but proved amply strong to withstand the pressure, with the standard cross-section and banquette reinforcement. (2) The 40 ft. width of banquette proved of inestimable value, for it afforded material from its outer half to top some ten miles of low grade levee, where earth could not otherwise have been obtained except under great difficulties. (3) The most vulnerable feature of the levee system is the instability of the foundation along much of the line, which evil is greatly aggravated by the existence of excavations for borrow pits on the land side of the levee.

The passage of water in large volume through permeable strata under the base of the levee constituted the most formidable danger to be combatted, requiring the most attention and effort. This evil has of course been much in evidence in former high waters; and, wherever such development has occurred a permanent remedy was applied by building sub-levees behind the main levee, so as to impond water over the area of defection of sufficient depth to control the situation. In one such basin of unusual extent (3,200 ft. long by 400 ft. wide) an 8-in. siphon over the main levee is used to hasten the filling of the pond. The sub-levees are provided with spillways of plank over the top, and iron drain pipes with gate valves underneath. The sub-levee device has been used in this

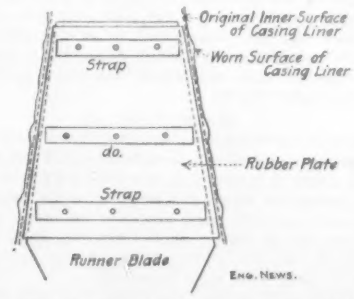


Fig. 6. Sketch Showing Manner of Attaching Rubber Straps to Blades of Pump.

levee district for a dozen years past, and has in every case proved a perfectly efficient remedy.

The development of foundation weakness in many new localities this year will require a corresponding extension of the sub-levee principle; and, with increased river stages that may be expected in the future, the necessity for making adequate provision to meet this source of danger will become still more pronounced. (4) Two other difficult problems that were especially emphasized during the recent high water, and for which no very satisfactory

solution has been found, remain to be considered: The one is, the protection of exposed salients in the levee line from erosive action of the current; the other is the protection of the levee from wave wash when it is much exposed to storms.

Taking up first the exposed salients: These are points where a decided change occurs in the direction of the flow of the flood water along the levee line, accentuated by a steepened slope due to short cuts across bends of the river. The degree of the menace to the levee depends upon the comparative abruptness of the turn, combined with the degree of steepness of the slope.

In the more severe cases the attack takes the form of vertical scour, tending to undermine the levee, as well as of lateral erosion tending to wash away the front slope. In the milder cases lateral erosion alone has to be reckoned with; or if there is vertical erosion also it is not difficult to control.

In this levee district are seven such exposed salients, including one that is not an angle, but the "loose end" of the "front line" on section 91, below Rescue landing, which, to use a military term, is "in the air."

The "front line" projects nearly four miles below the "Ward Lake line," a cross-levee connecting the front and back system, and terminates abruptly on the upper side of the bend in the river on the lower side of which bend is Sunflower Landing.

The method of protection used for these exposed points is to project a spur levee 200 to 300 ft. long, from the salient angle of the levee, out into the current, protecting the head of the "spur" by a plank bulkhead, with plank or brush revetment on the ground surface, and permeable brush dikes to moderate the violence of the current around the bulkhead.

During the recent high water no serious difficulty was encountered in maintaining these "spurs," except in the case of that one on section 36 (about two miles below Mhoon's Landing), and the levee end below Rescue—section 91.

The current around the 36 "Spur" was exceedingly violent, the fall there being nearly 4 ft. from one mile above to one mile below, with an abrupt descent of nearly 1½ ft. immediately around the "Spur" end. The vertical scour was more than 20 ft. around the bulkhead, most of which was carried away. The "Spur" was held with difficulty, and gave occasion for considerable anxiety. It is now proposed to cut off about half the "Spur," reducing the length to 150 ft., in order to afford more room for the passage of the water around it, and as a matter of additional security to construct a reserve line of levee behind the salient, in a regular curve, tangent to the levee line above and below. This reserve levee is to be 1,100 ft. long, the center of the curve being retired 300 ft. behind the salient in the main line.

On the levee end on section 91, a very elaborate and carefully constructed protection work was carried away completely in a few hours, some days before the flood culminated. The levee end receded 260 ft., in despite of energetic and persistent efforts to restrain it, the ground being scoured away to a depth of 10 ft. below the base of the levee throughout that distance.

The signal failure to protect this levee end from the violence of the current in that locality, in connection with certain bank-caving complications also, has induced me to recommend to the Levee Board that further efforts to maintain this projecting levee end be abandoned.

This will involve a radical change in that part of our system of levee protection, as the projecting levee end below the Ward Lake line incloses a "back water" basin, and controls the highwater elevation in same, to which the present grade of ten miles of levee is adjusted.

It will remain therefore either to build up the Ward Lake line to the headwater grade, or to build an interior line further up, to connect the front and back systems, and throw out the "front line" below the point of divergence as well as the Ward Lake line. There are many reasons, which will not be here presented, for favoring the latter course.

WAVE WASH.

A very violent wind storm occurred, after the flood had subsided from one to two feet, that created much alarm for the safety of the levee on the Friar's Point front and the Pushmatchee front, and other localities, and it required very energetic work for 10 or 12 hours to resist the action of the waves, notwithstanding which inroads were made into the middle of the crown of the levee in places, before the wind subsided.

The inefficiency of the "log booms" in such a violent storm, upon which reliance had been placed, was fully demonstrated. It is necessary to devise some more effective appliance to protect exposed portions of the levee from wave action.

The method now proposed to be used is to construct plank revetment walls on the exposed slope of the levee, the walls to be nearly vertical, with a slight batter towards the crown of the levee; the plank to be 2-in. cypress, on 6 × 6-in. posts spaced 5½ ft. apart, both treated with a wood preservative; the revetment to extend 1 ft. below the surface of the levee slope, and project 3½ ft. above; to be backed by earth the top surface of which shall extend from the top of revetment wall with an ascending slope of ½-ft. in 12 ft., to the levee slope above; the wall secured by tie-rods to longitudinal anchor timbers sunk in the levee above, and supported by anchor posts, set opposite the revetment posts, through both of which the tie-rods are to pass. Each terrace is thus to cover a vertical distance of 4 ft. on the levee slope, and a sufficient number of such terraces are to be constructed to cover the whole vertical distance of levee that is attacked by wave action.

SIDEWALK BUILDING AND SIDEWALK GRADES IN SMALL TOWNS.

By Ernest McCullough.*

A small town (less than 2,000 inhabitants), having no engineer resident therein, recently incorporated, and one of the first things attempted was to compel property-owners to build sidewalks. This was resisted by some, but in court the town was shown to possess the right to compel sidewalks to be built; so needy carpenters proceeded to sharpen and set saws, and the lumber yards increased their stock of 2-in. stuff.

The decision stated that grades had first to be established. Not a man in the place had any previous experience in such work, and only one man there knew anything about the handling of instruments. He had none, but offered to buy a level if appointed Town Engineer. The Council paid no attention to his offer, but proceeded to establish a grade by requiring sidewalks to be built on certain streets

on a straight line from the floor of ..... store on the ..... end of block No. .... to a point ..... inches below .... floor at the ..... end of said block.

The town attorney drew the resolution with the assistance of the leading local builder. Only the sidewalks in front of the stores indicated were put in. Other property-owners claimed the right to be treated as fairly by having the sidewalks laid on a level with their floors. Some men who had lived in larger places contended for a survey and scientific fixing of the grades. So the local man set stakes by using a straight edge and carpenter's level and a resolution was passed fixing the grades along the tops of these stakes.

The objectors claimed, with reason, that the grade would be lost if the stakes rotted, and also proved the "stake business" to be well-nigh worthless by hammering a few down, and then demanding that they be restored to their original heights, saying the records should be complete enough to enable this to be done.

Since the records did not show all that was necessary the Council determined to have a survey made. The writer was corresponded with, but his price was deemed excessive. A man in a neighboring town was secured who charged exactly one-fourth as much. It happened to be his first experience in city work, although he is a gray-headed man. All his life has been spent in surveying section lines and "pegging" an occasional ditch, with a few land surveys.

The grade ordinance passed when his work was completed, referred to

that grade established on a certain profile marked .... now on file in the office of the Town Clerk and filed therein on the ..... day of .....

*Civil Engineer, Lewiston, Idaho.

The Marshal served notices for building sidewalks, and lumber was bought. The end of the trouble was apparently in sight. All that the property-owners then wanted was some indication of heights. The surveyor was communicated with, and it was found that he considered the work done which he had contracted for. He had established the grade. To set the grade stakes for construction would cost them $5 per day and expenses, or $1 per lot! The engineering profession distinctly lost standing in that community. An acrimonious correspondence ensued because the Council in the first place did not know what was wanted, and because the surveyor, if he did know, failed to give what was needed. The discussion came to an end when the surveyor stopped replying to the Clerk's letters. The latter felt better then, as it gave him an opportunity to express his verbal opinion of engineers to his sympathizing townsmen—a task congenial, for writing was to him a painful process at best.

The writer was again corresponded with. He was asked to state in detail what his price would be to do the work and what he would furnish. Having been otherwise engaged during the four months of the controversy, and knowing nothing about their troubles, his reply created a sensation. It was that he would undertake the survey only on condition that he be allowed to survey the whole town in order to study drainage conditions thoroughly. He would then furnish: (1) A contour map on a scale of 200 ft. to an inch; (2) a profile of each street showing ground surface elevations, elevations of door steps at property line, sidewalk elevations (old) and a grade line for each block; (3) a list and description of bench marks; (4) a grade ordinance for each block so grades could be established by blocks or all at one time if desired; (5) a written report and directions to enable carpenters to put down the sidewalks without being under the necessity of calling in a sur-

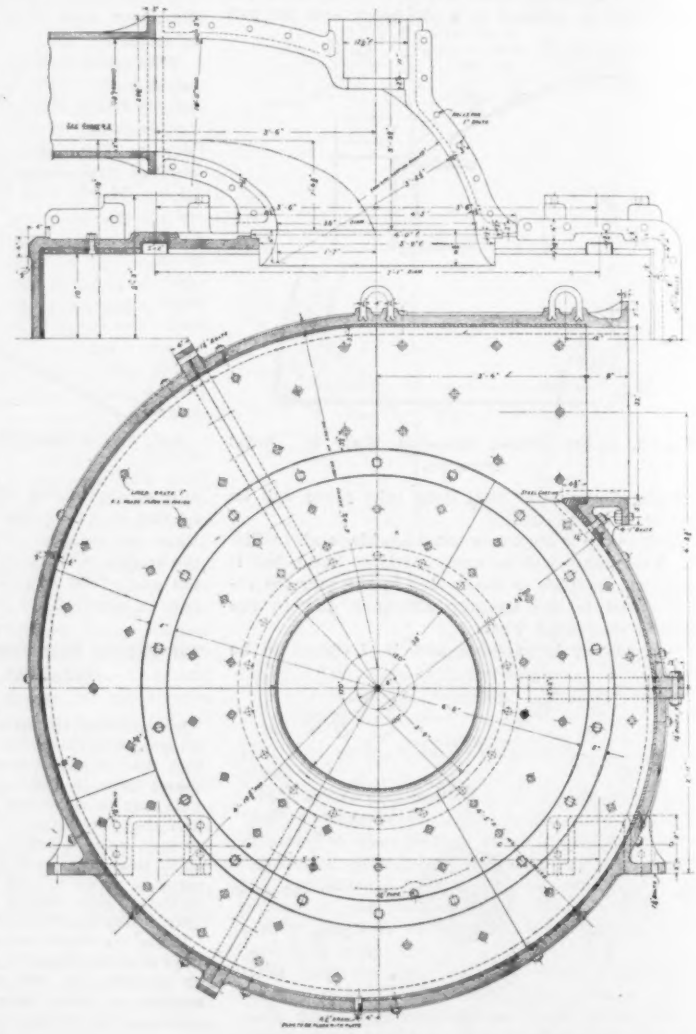


FIG. 7. DETAILS OF CENTRIFUGAL PUMP

veyor. The answer to his letter came by telephone, the harassed Councilman being tired of delay.

The survey was made by level and transit and stadia. In the business part of the town, which was comparatively flat, elevations were taken at each block corner and doorway and 100 ft apart on each side and along the center line. Sta. 0 was the intersection of the center lines of the two main streets. The stationing was continuous on each street and the corners and doorways were plus distances. At each point elevations were taken on sidewalks and on the ground. First a measurement was made with a tape and distances marked on doors of all buildings erected flush with the property line. The rod was held at the west side of doors on streets running north and south, and at the south side on streets running east and west. The foot of the rod was rested on the junction of the door sill and casing.

When the closely-built district was finished the level was used simply to get elevations at fence corners on street intersections and on porches and doorsteps for bench marks. The rest of the work was done by stadia, the ground being rolling.

A stream runs through the town, and with a very little work it can be straightened and kept on one street, which happens to parallel the main street. This stream receives all the drainage from a large territory, and after a sudden thaw the waters flood the downtown district. Therefore all the business houses are pretty well elevated. The writer found that the surveyor preceding him had established the grades on his profile (for he ran levels on two streets only), solely with reference to the buildings already erected, and drainage had evidently not been considered. The main street by his grade was several inches higher than the street back of it, and consequently would be a barrier to water trying to flow towards the stream.

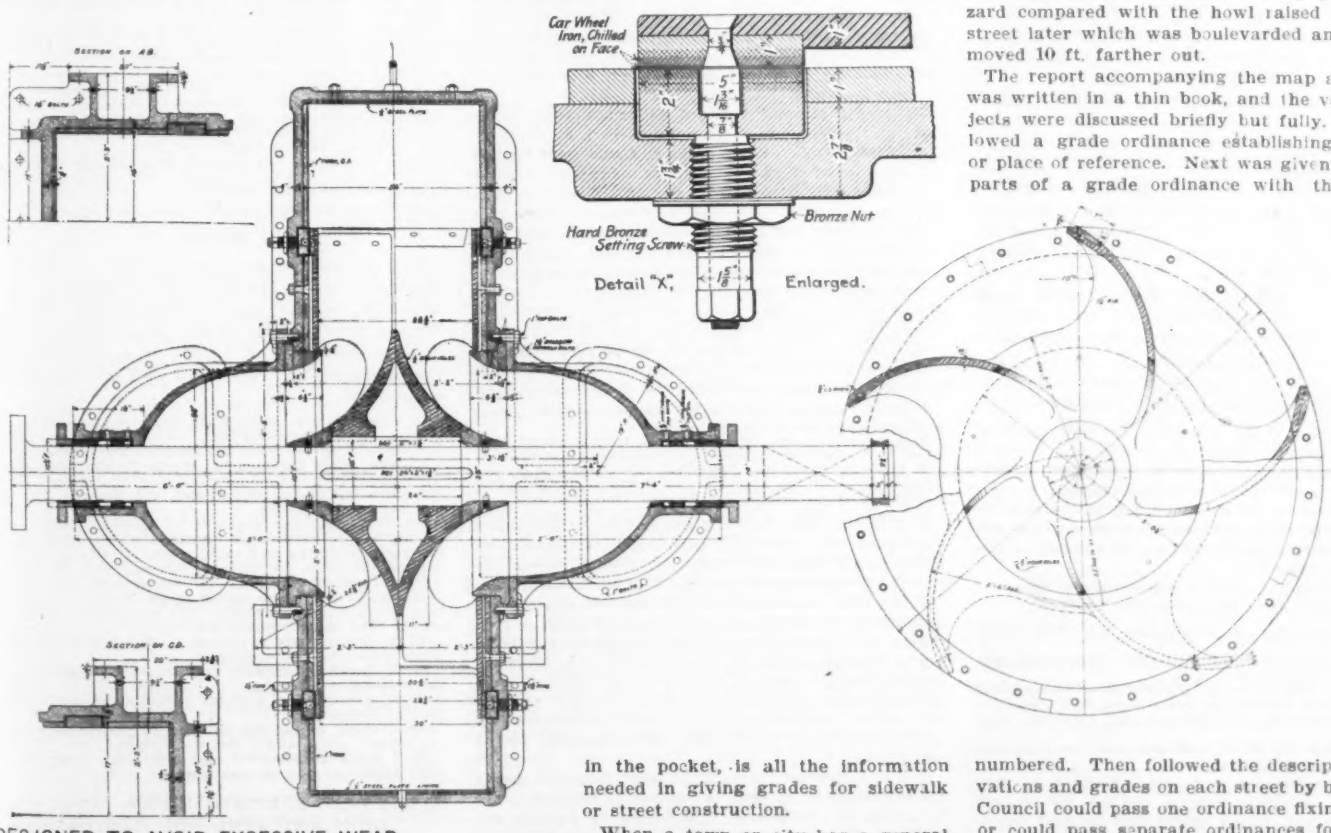
Such things are of frequent occurrence in many cities where surveyors are employed by the day or for a particular job, and are bossed by ignorant and self-important Councilmen or Village Trustees.

In this final survey the grade was established on the three parallel streets together, so that as little disturbance as possible might result to existing buildings, and at the same time permit a fall to the street on which the stream runs. The grades obtained were light, but owners were satisfied, as the line looked like a compromise. Of course the highest men wanted the grade raised up to their floors, and the men on the ground wanted a lower grade, but they finally agreed when they saw an attempt had been made at impartiality.

The contour map showed the stream fully. Contours were in full lines at 5-ft. intervals. Where the rise in any one block was less than 5 ft., intermediate 1-ft. contours (dotted) were given. Elevations were placed on the lines, the top of the stone monument at Sta. 0 being assumed 100 ft. above datum.

The writer always makes one side of a street lower than the other, for a slight difference of elevation is not noticeable to the eye, and is a great convenience when culverts have to be laid across the street. On the contour map, therefore, at each block corner a small circle was drawn, and in it were placed the figures showing the proposed grade elevation. This map, therefore, is useful to ascertain closely the cut or fill at each street intersection, and also to enable Councilmen to see along which streets to open gutters when the flow from the hills is troublesome. The uses of the map were explained in detail in the report.

A profile of each street was given, together with the grade line, and the elevations (in figures) at the corners. Doorways and sidewalks were also shown. The vertical scale was greatly exaggerated, and different markings indicated different sides of the street. The profiles were put in a Dunham Profile and Plat Book, the blank pages being used for a description of the bench marks. In one book, therefore, which can be easily carried in the pocket, is all the information needed in giving grades for sidewalk or street construction.



DESIGNED TO AVOID EXCESSIVE WEAR.

When a town or city has a general ordinance fixing the widths of sidewalks at some width proportionate to the total width, the best place for official elevations is on the curb line. Level turns at corners can then be avoided by reference to diagrams of the corners. If the sidewalk width has not been fixed, and a disinclination exists to fix it, then the official elevations had best be placed at the property line. Treatment of street intersections must then be left to the judgment and ingenuity of the man in charge of construction.

A grade is a rate. The average lawyer and citizen confuse grades and official elevations. The following form of ordinance shows the best method of stating things:

The City of ..... does ordain as follows:

Section 1. The following official elevations and grades are hereby established on ..... street, from the ..... line of ..... street to the ..... line of ..... street, the figures indicating the height in feet and decimal parts of feet above city base.

The official elevation at the intersection of ..... street and ..... street at the southwest corner, 103.1 feet; the southwest corner, 103.6 feet; the northeast corner, 103.1 feet; the northwest corner, 103.4 feet.

Sec. 2. The official elevations are hereby fixed at the property lines on the streets named, and the grades shall be on straight lines connecting the points at which the official elevations are by ordinance established.

Sec. 3. The slope across the sidewalk from the grade line at the property line to the grade line at the curb or outer edge of the sidewalk shall fall at the rate of one-quarter of an inch in each foot of width.

Sec. 4. The elevation of the grade line in the center of the street shall be determined at the time the street is paved or otherwise improved.

This matter has been mentioned fully because in five cities visited by the writer the grade was established on the center line of the street, and no difference made in speaking of grades and of elevations. Nothing was said about grades on curbs or on property lines. Each engineer had his own ideas in making improvements. The result was such as to lower the profession in the estimation of suffering house-owners. In two cities grades were fixed at the property line. In two, on the curb, and the sidewalk widths were not fixed by general ordinance. In one, the property line, curb line and center line were at the same elevation. A lawyer fixed that city. In the last place visited the grade is fixed on the curb line with the center of the street two-tenths lower, regardless of material. The slope upward from the curb to the property line is ¼-in. per ft. When the sidewalks lately on one street were narrowed there was a howl because some cement walks were thereby left high, and they were on grade when built. But that howl was as a summer zephyr to a blizzard compared with the howl raised on another street later which was boulevarded and the curb moved 10 ft. farther out.

The report accompanying the map and profiles was written in a thin book, and the various subjects were discussed briefly but fully. Then followed a grade ordinance establishing city base, or place of reference. Next was given the formal parts of a grade ordinance with the sections numbered. Then followed the descriptions of elevations and grades on each street by blocks, so the Council could pass one ordinance fixing all grades or could pass separate ordinances for any block or any street. By sandwiching them in between the numbered formal portions the job is done.

Following this was a description of the bench marks on each street. Then came the complete survey notes, so the map and profiles could be reproduced if lost or destroyed. Then came the directions for carpenters to build sidewalks. An isometric drawing was made of a doorway and a measurement being made from the sill to the grade elevation. This graphical description was followed by a list (by street and by block) of the abutting doorways and their elevation with reference to the grade. An example or two will suffice:

Wm. Matthews's door sill is 2⅝ inches above grade.
James Pitkins's door sill is 1 inch below grade.
Door sill of small house 131 feet south from corner is 3 inches below grade.

Of course all work on the profiles and all ordinance descriptions dealt with the decimally-divided foot. The carpenters, however, had to have inches, so in the report a table was given converting tenths into inches. Another table was given of the decimal equivalents of 1-16, ⅛, ¼, ½, ¾, of an inch.

Two examples were given and figured in full to show how, by means of straight edge and level, sidewalks could be laid from those built with reference to the door sill elevations. The work is being done. Some day when the town undertakes more work of an important nature the engineer selected will have good records to start with, provided some careless clerk does not let a carpenter take the book from the office. It is a "ten to one bet" the book will disappear and thereafter some carpenter will have a monopoly of sidewalk building.

SIXTH ANNUAL MEETING OF THE AMERICAN SOCIETY FOR TESTING MATERIALS.

The most successful convention ever held by this Society took place last week at the Kittatinny Hotel, Delaware Water Gap, Pa., nearly a hundred members and guests being in attendance.

The first session opened on Wednesday afternoon with the report of the Executive Committee, by which name the governing body of the Association is designated. This showed that the membership of the Association has doubled during the year, the total at the present time being 349. The financial report showed total expenditures of $3,777, of which about $2,500 was furnished by subscriptions. In order to place the finances of the Society on a better basis a new class of membership was recommended to be known as "contributing members" who should subscribe annually $50 toward the funds of the Society. The regular rate of dues is only $5 per year.

The Society maintains relations with the International Association for Testing Materials, and contributed $572 to that organization during the year. National societies for testing materials now exist in Germany, France, Italy, Hungary and Norway, and the total membership of the International Association is 1,937. The next International Congress is to be held in St. Petersburg, Aug. 18 to 24, 1904.

PROTECTIVE COATINGS FOR IRON AND STEEL.

The report of the committee on this subject was presented by its chairman, Mr. S. S. Voorhees. As the subject is one of much interest to our readers we print it, practically, in full, as follows:

The membership of the committee has been increased from the original 6 to 17 members, and the committee has aimed to include representatives of every class engaged in commercial production of protective coatings.

The three meetings of the committee held during the year have so far been confined to discussing the best methods of obtaining the desired data for a comprehensive report on this subject.

Before beginning this work it was considered necessary to put in concrete form several working headings:

1. Requirements for a satisfactory protective metal coating.
2. Methods used and suggested to determine if the protective coating is efficient.
3. An index, with abstracts, if possible, of general and current literature bearing on this subject which has appeared in English, French, German and American publications.
4. A classified list of all coatings used or suggested for the protection of iron and steel.

Sub-committees on the first two subjects have submitted reports; sub-committees on the last two subjects report progress and request further time for final report.

The report of the sub-committee on requirements for a satisfactory protective metal coating resulted in the following recommendations:

IN PREPARATION OF SURFACE FOR PAINTING, it is considered necessary that surface be free from grease and dirt, and that all detachable mill scale and rust be removed. Material which cannot be removed by hammer and chisel or wire brush, it is thought, will not affect the durability of the coating. The use of the sand blast is recommended, provided it is the opinion of the engineer that the cost is warranted, but it is not considered necessary in all cases.

APPLICATION OF THE PAINT.—It is recommended that the successive paint coatings should be as thick as possible, compatible with satisfactory spreading with the brush or machine. The brush marks should flow out. The paint should not contain any large amounts of volatile matter, so as to chill the surface by evaporation.

DRYING.—It does not seem possible, without further experimentation, to reach a final conclusion on this point. Whether the paint coats shall dry in six or twenty-four hours is a matter to be determined by the contingencies of the case. In general, it is recommended that as much time as possible be allowed between coats. It is, however, considered practicable to have an efficient metal coating dry in eight hours.

SUCCESSIVE COATINGS.—The under coatings must not be softened or acted upon by the subsequent coats of paint.

PROTECTIVE POWER.—This is the keystone of the whole subject. The coating must protect. To accomplish this it is recommended that the coating must have the maximum impermeability to moisture, air, and carbon dioxide. Iron and steel will not rust in dry air or in water free from air and carbon dioxide. The best protection will, therefore, be obtained from the most impervious coating. To this end the pigment should be as finely ground as possible; and, finally, it is recommended that the vehicle or pigment, or both, be water repellent. Whether this last characteristic is to be obtained by a pigment such as lamp black, or by the use of some non-drying oil, must be the subject for further investigation.

DURABILITY.—It is the opinion of the committee that coatings should be efficient under ordinary conditions for at least five years. The durability measures the life of the coating: it should therefore adhere to the metal through all ranges of contraction and expansion without peeling or cracking.

Neither the pigment nor the vehicle, nor compounds resulting from a reaction of the two, should cause a disintegration of the coating.

It is further recommended that the coating should not be affected by products necessary for the maintenance, equipment or use of the structure protected. This applies especially to the softening of paint on bridges by burning and lubricating oils from passing trains.

It is finally recommended that the coating be of such a character as to successfully resist the mechanical injury due to sand, cinders, and other material carried by the wind.

FEASIBILITY OF RECOATING.—There can be no question that a satisfactory coating must permit recoating when needed without additional labor for cleaning and removing old coat.

COST.—Upon this point it is only necessary to say that the other valuable requirements being obtained, that coating is best which can be furnished and applied at minimum cost.

SUB-COMMITTEE ON TESTS TO DETERMINE EFFICIENCY OF COATING.

It is the opinion of your committee that it is useless to prescribe the same tests to all classes of protective coverings. An efficient coating in the dry atmosphere of the Western states may fail to withstand the moist saline air of the coasts. A coating which is perfect for structural steel under a static load may fail entirely when subjected to vibratory shock imposed on bridge members and steel cars. In short, tests must be in harmony with conditions imposed in service.

The general cause of failure of coatings to protect is the same as the corrosion of the metal itself, i. e., moist air and carbon dioxide. Dilute acids, as a rule, have far less action on paint films than alkaline solutions. A paint made from some inert pigment and linseed oil will show no sign of disintegration when immersed for days in a dilute sulphuric acid solution which would rapidly dissolve the metal it protected, and the same paint would go to pieces in a few hours when exposed to the action of a correspondingly strong solution of ammonia or carbonate or caustic alkalies. Strong acid solutions rapidly destroy the coating, but it is rare that such conditions exist, and, if necessary, can be met by special requirements.

It is recommended that tests be adapted to the demands of service conditions, and divided into three broad classes:

1. Actual service tests, under normal conditions, applied to structure to be protected.
2. Accelerated tests, applied to specially prepared surfaces, and subjected to abnormally severe conditions.
3. Chemical tests to determine the constituents and adulterations of the pigment and vehicle, as far as the knowledge of the subject will admit.

It is undoubtedly true that the first set of tests gives the desired information in a most conclusive manner, but, unfortunately, the truth comes too late to remedy the evil if the protection is insufficient to prevent corrosion.

It is further considered that the function of this committee is not to specify any covering or coverings as protective, but to specify tests which coatings must stand to assure maximum efficiency. It will therefore be necessary to work along the lines of accelerated and chemical tests, selecting those which harmonize with the results of long-time service experiments, and ultimately formulating laboratory tests which can be relied upon to give the desired information.

It should, however, be realized that in this work chemical analysis must be used to supplement experience, not to provide it. In general, it is known by previous experiments that certain pigments and oils give durability and protection, while others fail in these essentials; but it will not do to condemn the unknown without the aid of experience.

A review of the suggested accelerated tests shows a variety of methods to impose abnormally severe conditions. These tests have in some cases little connection to service requirements, but it is believed that the results obtained by the methods selected will be in harmony with long-time service tests.

It is expected that the following series of experiments can be conducted through the co-operation of railroads and consumers on one hand, and the manufacturers of standard coatings on the other, the former to provide the structure and labor and the latter the material to be applied:

It is recommended that two coats of the protective coating be applied to parts of full-sized structures, not less than one span of a bridge, one steel freight car, or, in general, one unit of dimensions corresponding to above. The surface to be prepared and coating to be applied as recommended under those headings.

At the same time, panels of tank steel 20 × 24 × ¼-in. are prepared and coated in the same manner as the structure and with the same batch of coating. The panels are coated on both sides and on edges of sheet. The work to be done indoors under favorable conditions for drying.

The panels are to have a ¼-in. hole bored in middle of upper end to facilitate hanging, and are to be stamped with serial number on both sides in upper left-hand corner.

Panels are prepared as above in pairs, one to be exposed "green" and the other to be thoroughly dried under favorable conditions before testing. The corresponding pair of "green" and dry panels are exposed under the roofs of train sheds, in roundhouses directly over smokestacks of engines, from trusses of bridges, on roofs of train sheds, roundhouses, and on roofs adjoining powerhouse stacks, etc., in tunnels, on docks in salt water and tidal rivers, where they will be immersed twice every 24 hours in salt and fresh water in the ebb and flow of tides.

In addition to above series of field panels, special laboratory panels on glass and tank steel are prepared in the same manner as the foregoing. The steel panels are exposed to the action of exhaust steam at a temperature not to exceed 150° F. for 12 hours each day, and ordinary atmospheric air for the remaining 12 hours; the test to be continued for 30 days.

The porosity is determined by noting the absorption of a drop of oil on the coating. If the film is impervious, the drop of oil will run down the panel in a narrow band the width of the original drop, but if the life of the coating has been destroyed the drop of oil will spread out to a more or less greasy blotch, depending on extent of disintegration.

The glass panels are tested for water repellent properties by treating the dried coating with a few drops of water. Evaporation is prevented by means of a cover glass, and the coating examined after the water has been in contact for 12 hours.

The capacity of the coating to withstand destructive agencies necessary to equipment and maintenance of structure will require special tests.

For steel cars and bridges the coating on glass is tested with lubricating and burning oils to determine if it is disintegrated. For refrigerating cars it is tested in the same manner with a common salt solution.

A further set of laboratory tests are made by coating saucers of sheet iron 8 ins. diameter 1-in. deep with two coats of paint. These saucers are filled with ordinary tap water and allowed to evaporate under cover to dryness: the water renewed until definite conclusions can be deduced.

Chemical analyses of the coatings will also be made to determine percentage of pigment, oil and volatile matter, with composition and quality of each.

The above service and laboratory tests are to be conducted at as widely distant points, and under as different conditions, as possible. The service tests are to be carefully examined at stated intervals, and the entire series of experiments accurately tabulated for comparison with the long-time service tests.

From these data it is expected that laboratory tests can be formulated which, when met, will insure a satisfactory protective metal coating.

MAGNETIC PROPERTIES OF IRON AND STEEL.

The committee on this subject consisted of Messrs. R. G. G. Moldenke, J. A. Mathews, H. E Diller, W. A. Laymar, R. B. Treat and Prof. J. Walter Esterline, Chairman. The report presented by Prof. Esterline as framed at a meeting of the committee held at New York city on June 26 was as follows:

(1) That for the present, at least, the committee will consider in its investigations, only those subjects which have a bearing of practical commercial importance.
(2) That, with the approval of the Society, the committee will attempt the preparation of a bibliography of the literature in the English, French and German languages relating to the subject.
(3) The committee proposes to conduct investigations to enable it to recommend a method of obtaining samples for magnetic tests and a rapid means of making magnetic determinations on the different kinds of iron and steel.
(4) A chemical, magnetic and microscopic study of cast steel, with a view to ascertaining those mixtures and heat treatments which produce the best magnetic iron consistent with other requirements.
(5) A similar study of cast iron, except in so far as the above refers to heat treatment.
(6) A chemical, magnetic and microscopic study of steel for permanent magnets.
(7) Investigation of methods of hardening steel for permanent magnets.
(8) A study of the deterioration of permanent magnets of different alloy, under varied conditions.
(9) A chemical, magnetic and microscopic study of sheet steel under varied heat treatments.

STANDARD SPECIFICATIONS FOR CAST IRON AND FINISHED CASTINGS.

This committee, through Mr. Walter Wood, its chairman, submitted a preliminary report only and requested to be continued. On Thursday afternoon the committee held a meeting which was attended also by many members of the Society and prepared a preliminary draft of specifications under which pig-iron will be graded by analysis and not by fracture. The analysis of each grade will be stated, and rules will be laid down for the sampling and test of shipments to determine their grade.

MISCELLANEOUS BUSINESS.

The only officers to be chosen this year were two members of the Executive Committee. Messrs. A. L. Colby and John MacLeod were chosen for these positions.

Following this a discussion took place on experience in testing cement and concrete. It was urged that in crushing tests the point where the first sign of failure occurs be recorded as well as the ultimate strength. One member had found in crushing concrete cubes that the first failure occurred at about 50% of the ultimate load. Another favored the transverse test for cement and concrete as giving more real information as to the reliability of the material than either tensile or compressive tests. It was objected to this, however, that these materials are not used as beams and the modulus of transverse strength would not enable one to gage the ability of cement or concrete to carry compressive loads.

After further discussion the Executive Committee was empowered to create a committee to act in conjunction with representatives of other societies in investigating of concrete-steel.

WEDNESDAY EVENING SESSION.

The session on Wednesday evening opened with the presidential address, delivered by Dr. Chas. B Dudley, who took for his subject "The Making of Specifications" and described in detail the practice which has been developed during the past score of years by the Motive Power Department of the Pennsylvania R. R. We print this address nearly in full, on another page of this issue.

Following the President's address Mr. A. Cushman of the United States Laboratory for Testing Road Material, read a paper describing the work of the laboratory.

The samples of rock submitted are subjected to three tests: for hardness, toughness and binding power. The test for hardness is made by placing samples of the rock in a rattler consisting of a cylinder with its axis at an angle of 30° to its axis of rotation, the machine being of the well-known type originally developed in the French Ecole des Ponts et Chaussee, and now in use in road material testing laboratories everywhere. The test for toughness is made by submitting a piece of the rock, cut with a core drill, to an impact test. To determine binding power, a piece of rock is ground to powder in a ball mill and briquettes are made from the powder after sifting. These briquettes are then tested in another impact machine.

Mr. Cushman said that the Bureau in its tests takes into consideration the fact that different classes of roads demand different materials and roads were now classified according to their traffic as city, urban, suburban, highway and country. The softer rocks are of course adopted to roads of light traffic, while only the hardest stone can endure the heavier traffic.

It may interest some of our readers to know that the laboratory undertakes to make tests and report upon samples of road material free of charge for any citizen of the United States.

Mr. Johnson of the Maryland Highway Commission in discussing the paper, urged the necessity of standardizing practice in the testing of road materials, so that different laboratories would not obtain widely divergent results from the same material, as now often happens. On motion of Mr. L. W. Page of the United States Road Material Laboratory the Executive Committee was requested to consider the appointment of a committee on standard methods of tests for road materials.

The final paper of the evening was by Prof. W. Kendrick Hatt, describing the scheme laid down for the new timber tests to be undertaken by the Bureau of Forestry.

SPECIFICATIONS FOR IRON AND STEEL.

The session on Thursday morning was devoted to reports of various committees on iron and steel specifications. The first was presented by Mr. Wm. R. Webster, chairman of the Association's committee A, on standard specifications for iron and steel and it described the progress which had been made in bringing various societies into harmony on the matter of standard specifications for various forms of finished iron and steel. This work is still in progress. The most important by far of the changes which bids fair to be brought about is the adoption of a single grade of steel for all structural purposes.

Following this Mr. C. C. Schneider presented the standard specifications for iron and steel structures adopted by the American Railway Engineering and Maintenance of Way Association. The characteristic features of these specifications are the adoption of a single grade of steel of 60,000 lbs. tensile strength with an allowable variation of 5,000 lbs. either way, and the omission of any requirement as to reduction of area or elastic limit for the test specimen. Mr. Schneider explained that the elastic limit was omitted because the committee could not agree upon any method for its determination.

Since the single grade of structural steel was proposed, it has been adopted in the specifications of many large railway companies, and is considered also satisfactory for ship frames and sheathing.

On the matter of mill testing, the feeling of the committee is that more importance should be put upon full-sized cold bending than has obtained in the past. The tensile tests and chemical investigations show the grade of steel and the work of the furnace; but to check the work of the rolls, the reheating furnaces, if any are used, and the final heat treatment, it is thought that cold bending either plain or nicked is indispensable.

Next was presented the specifications for steel rails of the American Railway Engineering and Maintenance of Way Association. The committee of that Association is this year to consider the matters of drop tests, and shrinkage and to confer with the committee on track with regard to a standard drilling for rail ends. The committee of rail manufacturers have suggested the following standard drilling for consideration:

All holes 1-in. in diameter.

For 4-hole splice, 2½ ins. to 5 ins.

For 6-hole splice, 2½ ins. to 5 and 6 ins.

It is under consideration whether for heavy section rails a larger hole than 1 in. should not be used.

Mr. A. L. Colby of the Bethlehem Steel Co. then presented the Standard Specifications for steel adopted by the Association of American Steel Manufacturers as finally revised Feb. 6. 1903. These specifications as originally framed in August, 1895, represented the first successful effort to standardize steel specifications. They rapidly grew in favor with customers, who found that by their use they were able to secure greater competition and more prompt delivery. These specifications now omit the full-size eye-bar tests, as it is held to be unjust to hold the steel manufacturer responsible for material after it has been subjected to manipulation in the bridge shop.

Next Mr. Wm. Kent reported the conclusion reached by the American Society of Mechanical Engineers' Committee on Specifications for Steel Forgings, Castings and Boiler Plate and Mr. F. H. Clark reported for the Committee of the American Railway Master Mechanics' Association on Locomotive Axles and Forgings.

The notable feature of the Mechanical Engineers' report was the discarding of elastic limit requirements. The Master Mechanics' Committee specifications follow quite closely those proposed by the Association for Testing Materials. A noteworthy feature is the method of taking the sample for test. This is cut from the end of the finished axle by a core drill boring four or five inches deep. Such a specimen is truly representative of the axle and taking it does not at all injure the axle for use.

A general discussion on steel then ensued and took a very broad range.

The President, Dr. Dudley, called attention to the general tendency toward the use of harder grades of steel in all classes of machinery. In locomotive fireboxes, for example, the softer steel does not hold the stay bolt threads well and the sheets are abraded by the coal, so the tensile strength of firebox steel has been raised 5,000 lbs.

The first steel axles were made of a very ductile steel which stood the drop test so admirably that it was considered an ideal material. These axles, however, after running about two years, gave trouble by fracture in detail. They were made of steel of about 65,000 lbs. tensile strength and 0.15 carbon. It was evidently necessary to either increase the size of the axle or use a stronger steel, and a new specification was made calling for 80,000 lbs. tensile strength and carbon 0.30 to 0.50, and the difficulty disappeared as by magic. Out of over 300,000 steel axles put in service under this specification only four or five have broken and these breakages have generally been traceable to the presence of flaws due to piping. For the past three years, although the specifications for axle-steel name 0.50 carbon as a maximum, none has been rejected for high carbon unless over 0.55.

Mr. Huston agreed that a harder steel was advantageous for fire boxes, but thought that the softer grades should be used for parts of boilers subjected to severe flanging, particularly where this has to be done by hand. He urged that in justice to Eastern manufacturers the restriction as to sulphur be not carried too far in the specifications. Unless the steel is to be under stress when heated he thought a moderate amount of sulphur could do no harm to the steel.

Referring to the question whether the same grade of steel could be used for ships and bridges, Mr. E. Platt Stratton pointed out that the steel should be soft enough to work well hot, as in the case of bending frames, hull plates, etc. Too soft steel, however, was apt to bulge between the frames from lack of stiffness.

Considerable discussion took place on the question whether steel of high carbon would rust more or less rapidly than soft steel; but the weight of opinion was that the harder steel would resist corrosion longer.

Another subject discussed was the cracking of fire-box plates. Much more trouble was experienced with this years ago than at the present time, and this is one reason why it is now feasible to use a harder steel for this purpose. One speaker claimed that the cracking was due to punching the stay bolt holes without reaming, but Mr. Jas. Christie replied that it was unnecessary to ream holes which were to be tapped as the tapping removed enough metal to check the incipient cracks due to punching.

The morning session was finally concluded by the adoption of a motion to refer the whole matter back to Committee A for further consideration.

NICKEL STEEL.

Thursday afternoon was spent by most of the members in carriage drives and steamer excursions on the Delaware. The evening session was opened with an elaborate paper by Mr. Albert Ladd Colby on Nickel Steel, giving the results of the latest investigations and practice respecting that material. The commercial use of nickel steel may be said to date from 1889 when Mr. James Riley of Glasgow read an elaborate paper on the subject before the Iron and Steel Institute. Its extensive adoption for armor plate followed almost at once and it has since been applied to a wider range of uses every year.

Following Mr. Colby's paper some interesting applications of nickel steel were described by other speakers. Dr. Dudley said that half a mile of 3½% nickel steel rails were laid on the 9° Kittaning Point curve west of Altoona about three years ago, where ordinary carbon rails had an average life of 10 months. These rails have just been relaid elsewhere, although they are not by any means worn out and the Pennsylvania R. R. has ordered 5,000 tons more of nickel steel rails. In reply to a question Mr. John Macleod of the Carnegie Steel Co. said that 3½% nickel steel rails cost about $56 per ton and were worth about $14 per ton more than ordinary rails when worn out on account of their nickel content. Thus in situations where carbon steel rails wear rapidly, nickel steel rails are cheaper.

Mr. Colby also exhibited the new boiler tubes of 30% nickel steel which have just been put on the market by the Shelby Steel Tube Co. These tubes offer a high resistance to corrosion. They will cost about three times as much as ordinary steel tubes, but the trouble and expense now experienced with the pitting of boiler and condenser tubes, particularly in marine service is such that these tubes are expected to be well worth this high cost.

PIPED INGOTS AND PIPED RAILS.

Next came a paper by Messrs. Albert Sauveur and Jasper Whiting on "The Casting of Pipeless Ingots by the Sauveur Overflow Method." Mr. Sauveur's system consists in connecting up a series of several ingot molds, so that the overflow

from one mold flows into the next in the series. The molten steel is teemed into the first mold. The idea of the process is that the tops of the ingots are kept fluid while the rest of the ingot cools. Thus the center of the ingot is fed and no hollow or pipe can form. Mr. Sauveur also claimed that by this process segregation in the ingot would be reduced. The metalloids are well known to concentrate at the part of the ingot which solidifies last because their melting point is lower than that of the pure steel. Thus, the percentage of metalloids is higher near a pipe. With this process, however, the metal high in metalloids is washed into the next ingot and distributed through its mass. Mr. Sauveur acknowledged that the first ingot in the series poured by his process would benefit most, and the others in decreasing proportion.

The Sauveur process has been tried in casting crucible steel ingots and is now being introduced at an open hearth plant. It is also shortly to be introduced at a Bessemer plant.

Mr. Martin thought that the process would offer many practical difficulties. Pouring all the molten steel for a series of ingots into one mold would badly cut away the sides of the first mold. There would also be difficulty in stripping the ingots. He had tried Mr. Sauveur's idea in the early '90's, but after he had poured the ingots they were all connected together and it was not feasible to separate them.

A general discussion then ensued on the kindred subject of piped rails. Mr. Sauveur exhibited drawings showing a badly piped ingot and a horribly piped rail section and declared that the cropping of ingots as generally practised was wholly insufficient to remove the pipe. The pipe extends, said he, from 20% to 40% of the length of the ingot, while manufacturers seldom discard over 10%. Under present practice, therefore, the first rail rolled from every ingot, or say one rail out of every six put in service is a piped rail. These piped rails may or may not be dangerously weak, but at least they are not as good as the others from the ingot. Mr. Sauveur saw no remedy for this condition save one so drastic that it would probably not be applied; but he urged at least that any test specimens should be taken from the crop end of the first rail of the ingot and any drop tests should be made on the first rail from the ingot.

Mr. Robert Job, Chemist of the Reading R. R., said that fortunately these piped rails resulted in comparatively few fractures; yet of such rail fractures as did occur, 75% could be traced to the presence of piping. He agreed that the rail taken for a drop test should be the first rail from the ingot and said that a large majority of the rails which break under the drop test contain pipes.

Mr. Jas. Christie suggested that piping of ingots was due to the more rapid working of recent years and that the sound, homogenous rails made in the early days of the steel industry were due to the fact that the small ingots then made were forged under the hammer so that any interior cavities were thoroughly welded together. Other members opposed this and said that a pipe or cavity once formed could not be perfectly closed by any pressure on account of the oxidized surface of the cavity.

Mr. Martin said that if badly piped rails were so common as Mr. Sauveur claimed he did not propose to return home by rail and advised every one to take the highway for travelling. As a matter of fact, he did not believe that ingots were so badly piped as Mr. Sauveur claimed, or that badly piped rails were knowingly made by the mills.

Mr. John Macleod of the Carnegie Steel Co. took a similar position and thought it quite possible for an inspector at the mill to prevent any badly piped rails from passing. By stationing himself at the point where the blooms are cut up, he thought it quite possible to detect any piping. Any mill superintendent who saw such an ingot come forward as that shown by Mr. Sauveur would order it cut up and sent back to be remelted.

Mr. Martin asked whether Mr. Sauveur thought all the bad rails came from ingots having a hollow top, and receiving an affirmative reply, Mr. Martin declared that there were numerous causes besides hollow tops which could and did produce piped rails.

Mr. Macleod thought that if railways would station their own day and night inspectors at the rolling mills they would get fewer piped rails than they do now, notwithstanding the desire of the manufacturer to deliver only a perfect product. Regarding the suggestion that the first rail be selected for test he urged that it would be inconsistent if this rail should fail to reject the rest of the rails from the ingot, which were in all probability of better quality.

The evening session closed with a statement by Col. E. D. Meier, giving a brief history of the attempts made by the American Boiler Manufacturers' Association to secure revision of the U. S. rules for marine boiler inspection by an expert commission. Col. Meier requested the aid of the Association toward such legislation and the matter was referred to the Executive Committee for action.

CAST IRON.

On Friday morning the Society met in two sections, one with the President, Dr. Dudley, in the chair, listened to a number of papers on cast iron; The second presided over by the Vice-President, Mr. R. W. Lesley, took up the subjects of Cement and Bitumen.

The cast-iron section opened with a paper by Mr. A. E. Outerbridge on "The Importance of Adopting Standard Sizes of Test Bars for Determining the Strength of Cast Iron." The following is condensed from Mr. Outerbridge's paper:

It is a fact well known to founders, that the physical properties of cast iron, such as strength, hardness, ductility, coarse grainedness or "fracture," etc., depend not alone upon the chemical constitution, but also upon the rate of cooling of the metal from the fluid to the solid state.

It is quite possible to obtain from one ladle of molten pig iron, castings having widely different physical properties, covering the entire range from hard white iron to soft grey metal, by simply regulating the rate of cooling of the iron when poured into the castings.

Let us assume that we have metal of approximately the following composition in a ladle:

Graphitic carbon ...	3.00%	Phosphorus	.50%
Combined carbon ...	.75%	Sulphur	.10%
Silicon	.65%	Iron	94.85%
Manganese	.15%		

Suppose that we cast this metal into a solid wedge-shaped bar 6 ft. long 6 ins. square at the thick end, tapering to ¼-in. square section at the thin end. If we break the bar into short pieces, say about 6 ins. in length, we will find almost every grade of cast iron (as shown by the fracture), from white iron at the thin end of the wedge, to dark grey metal with coarse-grained fracture at the thick end, between these two extremes we will find intermediate grades of cast iron. If we now cut from the grey portion of the bar, pieces of convenient size for tensile tests, we will find, on pulling them in a testing machine, astonishing variations in the strength of the metal.

A chilled cast-iron car wheel is a more familiar illustration of a casting having widely different physical properties in its different portions, depending upon the rate of cooling of the metal, the tread, or rim, which is cooled quickly, in white iron while the "plate" or body of the wheel, which is cooled more slowly, is grey, and the hub, which "sets" still more slowly, is usually quite soft, coarse-grained dark grey metal. Tensile tests of the grey iron in the plate and that in the hub of a wheel show great difference in strength. In one test the iron from the plate of a wheel gave tensile strength of about 30,000 lbs. per sq. in., while the metal from the hub of the same wheel showed tensile strength of less than 20,000 lbs. per sq. in. The metal from the plate was comparatively fine grained while that cut from the hub was coarse grained.

If we should cast several test bars from one ladle of iron, all of the same length, say 15 ins., but varying in thickness ranging, let us say, from 1¼ to 2¼ ins. diameter, we would find if we should pull the bars on a testing machine, astonishing differences in tensile strength, the larger bars having, as a rule, much less strength per square inch than the bars of smaller diameter.

If we should cast several test bars all of the same size, from one ladle of iron and cool some of them rapidly, others slowly, we would find remarkable differences in strength and resilience of the bars, those which had been cooled quickly would, as a rule, be much stronger than those which were cooled slowly. I am assuming in all cases, except the first, that the metal would be entirely grey in the castings, i. e., free from any tendency to mottled iron.

Other similar tests have been made corroborating the foregoing, and all tending to show the importance of adopting standard sizes of test bars for determining the strength of cast iron when poured into castings of different dimensions.

Records of tests of cast iron are useless, for the reasons here given, unless the rough dimensions and finished sizes of the bars are stated.

The rate of cooling of cast iron from the fluid to the solid state is such an important factor in determining the physical properties of the metal, that it is just as important to know the dimensions of the test bars as it is to know the chemical composition. It is equally desirable, for the same reason, that standard sizes of test bars should be adopted which would be suitable for different grades of iron.

At the present time the whole matter of testing cast iron is in such a chaotic state that few of the published tests are susceptible of comparison, one with another, or even of affording reliable information regarding the character of the metal. It is with the hope of drawing attention to this important subject that these brief notes are here presented.

Following this came a paper by Mr. E. S. Cook on "Machine Cast Sandless Pig Iron in Relation to the Standardizing of Pig Iron for Foundry Purposes," and then Dr. Richard Moldenke, Secretary of the American Foundrymen's Association, read a paper on the "Physical Properties of Malleable Castings as Influenced by the Process of Manufacture." This paper while short is of such value and importance that we reprint it separately elsewhere in this issue. The remaining paper read was one on "Cast-Iron for Dynamo and Motor Frames," by Mr. H. E. Diller, and a general discussion on the subject of cast-iron followed.

CEMENT AND BITUMEN.

The session of the cement and bitumen opened with the report of the Committee on Standard Specifications for Cement presented by Prof. Geo. H. Swain, chairman. We print the report in full as follows:

The committee met Oct. 30, 1902, and organized with the following officers: Chairman, Prof. George F. Swain; Vice-Chairman, George S. Webster; Secretary, Richard L. Humphrey. The membership of the committee was the subject of careful consideration and with the object of forming a large committee which should represent all the various interests involved. Subsequent to this meeting the committee was enlarged and now consists of 20 members.

A second meeting was held Feb. 4, 1903, and the work of the committee was discussed and a set of by-laws adopted.

It was evident that the work of the committee would consist of the adoption of standard methods for making tests, and the framing of a standard specification based on such methods. With regard to the first portion of the work, the progress report of the Committee on Uniform Tests of Cement of the American Society of Civil Engineers was adopted conditionally.

It was decided to send out samples of cement to the various members of the committee, and to such laboratories as would be willing to co-operate, and to request them to test the samples according to the rules contained in the progress report; the object being to ascertain if possible how closely the results of these tests agree, and to determine whether it is feasible to prescribe a standard specification based on these methods.

Samples of 5 Portland and 4 natural cements, with sufficient Ottawa sand, were sent to 30 laboratories, with a set of instructions and a copy of the progress report of the American Society Committee. Each laboratory was to test the samples, according to these rules, for specific gravity, fineness, time of setting, constancy of volume and tensile strength, neat and with Ottawa sand.

The results of these tests are now being sent to the Secretary, and will be compiled shortly for consideration and discussion. They are not in such shape as to be available in whole or in part, for consideration at this time.

Your committee is obliged, therefore, to confine its report to one of progress, reserving a more complete statement of the work accomplished for a later report.

Mr. Clifford Richardson, for the committee on bitumen, reported that Mr. A. W. Dow of Washington and himself who were appointed as members of the International Committee had endeavored to enlarge their committee but had found it very difficult to induce representative men to undertake the work. They finally secured the acceptance of Dr. Eldridge of the Geological Survey, Prof. Peckham and Prof. Phillips, but it was found impossible to organize into a successful and harmonious working committee, and he therefore requested that the committee be discharged. This action was taken by the Society.

Following this Mr. A. W. Dow, the other mem-

ber of the committee, read a paper on "The Testing of Bitumen for Paving Purposes." In testing asphalts to determine the action of water upon them, Mr. Dow coats a piece of glass with the paving cement, immerses it in water and examines it from time to time for evidences of discoloration. Another method is to make two cubes of the cement, immerse one in water and leave the other in air and compare their weights and dimensions from time to time.

This paper started a brisk discussion on the action of water on asphalt. Mr. Richardson said that he did not believe that the tests of the action of water on paving cements were of practical value. All asphalts, said he, if exposed to the continual action of water will rot. The action of water on asphalt was of importance formerly, but engineers now grade their streets so that water will not stand on them. It is necessary to keep water away from the under surface of an asphalt pavement, and he severely criticized the Washington authorities for using a 1, 4 and 10 concrete base for asphalt up. Water will work through such a concrete and ruin the asphalt. Gas from leaky mains is also ruinous to asphalt and water and gas together are far more destructive than either alone.

The discussion then turned on the use of asphalt for waterproofing and engineers present raised the question whether if water acted so injuriously on asphalt, it was a proper substance to use for waterproofing concrete or masonry. The query remained unanswered, but one valuable practical point brought out by Mr. Richardson was the impossibility of making a bond between asphalt and cold concrete. In applying asphalt to concrete or masonry, first paint the surface (which must be perfectly dry) with asphalt dissolved in naphtha. The asphalt can then be laid against this surface and will adhere.

The remainder of the session was occupied with three valuable papers on cement. The first by Mr. C. S. Gowan described tests on Portland cement mortars at low temperatures made in connection with the New Croton dam. The second by Mr. E. S. Larned, discussed the influence of different proportions of water and different sands on cement briquettes. The third by Mr. W. P. Taylor of Philadelphia related the experience with accelerated tests of Portland cement for soundness. We hope to present each of these papers in an early issue.

CONCLUDING SESSION.

The final session on Friday afternoon was rather thinly attended, as a number of members had left on the midday trains. Several of the papers set down for this session were read by title only.

Prof. Albert Sauveur showed a new invention called the thermo-magnetic selector for determining the temperature at which rails are rolled. The invention is based on the principle that steel loses its magnetic properties at or near the point of recalescence. It is proposed to place the instrument near the finishing rolls of a rail mill. If a rail is cool enough to be magnetic it will operate the instrument. If it is at too high a temperature it will not. Thus the rails rolled at different temperatures may be guided in different directions or it could be arranged to brand all rails rolled at too high a temperature.

In the discussion the invention was severely criticized. It was pointed out that it was the temperature during the whole rolling process that affected the quality of steel in the rail and not merely the last pass. By simply holding the rails before the last pass till it was cooled all rail would pass Prof. Sauveur's machine. Dr. Matthews suggested that the Morse optical pyrometer would be a much simpler method of determining whether rails passed through the rolls at too high a temperature.

Prof. J. Walter Esterline then described an apparatus for measuring the energy losses in transformer iron. By this instrument it is possible to make the same measurements on transformer iron in two minutes that formerly required seven hours.

Prof. J. W. Richards then presented a paper on light aluminum alloys with especial reference to alloys of aluminum and zinc. He expressed the opinion that these alloys would replace the alloys of aluminum and copper as they were both better and cheaper.

Mr. G. H. Clamer then presented a paper on tests of bearing metals and quite a discussion on the subject ensued, with especial reference to the prevention of hot-boxes in railway service.

Two items of business concluded the work of the convention: The Executive Committee was instructed to consider the matter of appointing a committee on alternate stresses of iron and steel, and a resolution was adopted that on all standing committees of the Association an equal balance be preserved between engineers and scientists or representatives of consumers and the representatives of manufacturers, and that the chairman of each committee should be selected from the former class by the Executive Committee.

A NEW MOLDING PRESS FOR MAKING CEMENT PIPE.

We illustrate in the accompanying cut a machine for molding cement pipe which has been somewhat extensively employed in Europe and is now being introduced into the United States by Mr. H. Schebye, Civil Engineer, 348 Carolina St., Oakland, Pittsburg, Pa. This machine uses a cylindrical mold, inside of which works a mandrel, which serves the double purpose of forming the inner surface of the pipe and of compacting the cement paste or mortar of which the pipe is made. In the illustration the reference letters *a* designate the cylindrical molds. As will be observed, they are made in two semi-cylindrical halves which are clamped together by a self-locking band, as

The Kielberg Molding Press for Making Cement Pipe.

clearly shown by the illustration. These molds are made with flanges or sockets as desired.

To mold a length of pipe, one of the cylindrical molds is set up concentric with the ring g. The plunger or mandrel b is then lowered into it until the helical thread d is nearly in contact with the bottom ring g. Enough cement to form the pipe socket is then placed inside the mold and the mandrel is rotated by means of the gearing shown. The effect of this rotation, as will readily be seen, is to cause the helical thread d to force the cement downward and fill the socket. The rotation is then continued, more cement being added at intervals and the mandrel being gradually moved upward, until the mold is filled to the top. The mandrel is then withdrawn from the mold and the latter with its contents and base plate is removed to the store room where the pipe is left to harden.

The construction of the molding machine is clearly shown by the illustration. The mandrel is hoisted and lowered by the hand-winch and rotation is effected by the pulley and train of gearing. The starting and stopping of the machine is effected by shifting the belt on the fixed and loose pulleys. The only part of the machine subject to much wear is the mandrel. This is, therefore, made with removable thread and shaft, which can be renewed as the wear necessitates new parts. The machine requires two attendants, and it is stated will turn out 100 pipes, each 10 ins. in diameter and 40 ins. long, per day. It is capable of making pipes of different sizes by simply changing the the molds and mandrel.

It is claimed that the pipes made by this machine are very smooth internally, and that, being molded under pressure, the concrete after hardening is very strong. The figures in the accompanying table below represent the breaking loads on pipes of different sizes, three months old. These tests were made by Dr. Toepffer, Finkenwalde, Germany; the pipes were laid flat, and loaded on the upper surface.

Table Showing Results of Tests of Cement Pipe, 3.28 ft. Long and of Various Diameters.

Composition of mortar.			Diameter inside, ins.	Thickness, ins.	Breaking load, lbs.
Cement.	Sand.	Small stones.			
1	3	..	7.87	1.03	6,455
1	3	..	9.84	1.10	6,305
1	2	1	9.84	1.10	7,059
1	1½	1½	9.84	1.10	5,855
1	1	2	9.84	1.10	5,324
1	3	1	9.84	1.10	5,789
1	3	..	11.02	1.18	5,216
1	4	..	11.02	1.18	5,027
1	3	..	19.78	1.57	5,247

Other tests made by the Royal Technical Academy, Stockholm, Sweden, showed that the cement pipes were stronger than those of glazed earthenware, and that they were also less porous. This was proved by placing nine lengths of each type of pipe upright, closing them at the bottom and filling with water. At the end of fourteen days the water level had sunk 23 mm. in the cement pipes, and 150 mm. in the earthenware pipes.

As some of our readers may be aware, the manufacture of cement pipe is not a new industry in the United States. For a number of years the Wilson & Baillie Mfg. Co., of 93 Ninth St., Brooklyn, N. Y., made concrete sewer pipe by hand and supplied a large quantity to the City of Brooklyn. In the early '90's a pipe-making machine, invented by Willis D. Sherman, of Omaha, Neb., was adopted by this company, and in Engineering News of May 18, 1893, the pipe storage yard of this company was illustrated. The Sherman machine consisted of a battery of vertical rammers which packed the concrete in the molds. It had the advantage over the machine here illustrated that it would make egg-shaped pipe, while the Kielberg machine illustrated, can make only round pipe, although we are informed that another type of the Kielberg machine makes pipe of egg-shape section.

We understand, however, that the cement pipe manufacture in Brooklyn has been abandoned for a number of years, the authorities preferring to use the glazed vitrified pipe. It is no doubt possible to make concrete pipe which shall be as strong or stronger than vitrified pipe, but it is objected that any variation in the composition of the concrete at any time is likely to produce defects which it is difficult or impossible to discover by inspection.

Another application of the Kielberg machine which may possibly prove of considerable industrial importance is the manufacture of molds for cast-iron pipe. Experiments in this line are now being made by a large German iron works.

ANNUAL MEETING OF THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.

The constitution of the Society for the Promotion of Engineering Education provides for yearly gatherings of its members in the following words:

> There shall be a regular meeting occurring at the time and place of the meeting of the American Association for the Advancement of Science, or of some one of the national engineering societies, or otherwise. . . . .

This year the meeting was held at Niagara Falls, N. Y., while the American Institute of Electrical Engineers was in session there. Common registry of attendance, common participation in entertainment, and, more important, one session held jointly for the common discussion of electrical engineering education, defined the coöperation between the two societies during the meeting.

While the American Institute of Electrical Engineers began its work on Monday, June 29, the first session of the Society for the Promotion of Engineering Education was held on Wednesday morning, July 1. The business of the session comprised committee reports, and the Presidential Address. Treasurer A. N. Talbot (Urbana, Ill.) reported the expenses and receipts of the Society during the past year, each side of the balance sheet totaling about $1,500.

The address of President C. M. Woodward (St. Louis, Mo.) centered around secondary schools; it argued that they need to take upon themselves much work now done by technical colleges, and reported great changes and advances in progress in their methods and their scope. The manual training high school is the coming great thing in education. On the other hand, primary school manual training is a dangerous fad, which needs to be done away with. An abstract of the more general portions of the address will be given in a future issue of Engineering News.

Committee reports were the next in order of business. The committee on Entrance Requirements for Engineering Colleges, Prof. H. W. Tyler (Boston, Mass.), chairman, had no results to report as yet, but stated that it was in active relations with various educational associations and schools. The report was accepted and the committee continued for another year. Professor Tyler presented his resignation as chairman, and it was accepted, his successor to be appointed by President Woodward.

Prof. Wm. G. Magruder (Columbus, O.), as chairman of the committee on Statistics of Engineering Education, reported that a chart of growth for the various technical colleges had been drawn up, which will appear in the "Proceedings." The committee contemplates preparing a list of degrees conferred by engineering colleges, and asks aid for this in the way of information. The committee on Industrial Education, through its chairman, Prof. C. M. Woodward (St. Louis, Mo.), reported that it has seemed best to work on this question in harmony with the National Educational Association. To this end, three members of the committee (Profs. R. H. Thurston, A. L. Williston, and C. M. Woodward) will read papers on the subject before the coming convention of that body at Boston. President Eliot, of Harvard, will deal with the same subject in his address.

TECHNICAL BOOKS FOR PUBLIC LIBRARIES.

The committee on Technical Books for Libraries, Prof. C. F. Burgess (Madison, Wis.), chairman, presented an extended report embodying a list of over 300 books on a variety of engineering subjects, suited for library purposes. The books range from the most elementary to reference works, in four grades, designated A, B, C, and D, and the list is arranged under about a score of headings representing different divisions of engineering. These headings are by no means all coördinate, as, for instance, one heading is Civil Engineering, while another is Batteries; certain divisions of engineering are not represented at all, as was pointed out in the discussion on the report. However, the report explained that most libraries were almost unprovided with technical works, or had only a small list as the result of demands by readers. This made proper selection of a list especially difficult. Some libraries, on the other hand, are especially provided, notably the Providence library, and the Carnegie library at Pittsburg. The report then suggested that regular, say yearly, revision of the list was desirable, which work might possibly be undertaken in connection with the American Library Association. Some lively discussion grew out of the question of what disposition to make of the report. Some thought it should be printed in the "Proceedings" in its present form, while others insisted that opportunity for criticism and revision be given by first printing the report in pamphlet form and distributing it to the members. The question was finally referred to the council for decision. At a later session the council recommended that the report be printed in the "Proceedings," but that it be also published in pamphlet form for criticism and revision; further, that the committee be continued for another year. These recommendations were approved by the Society.

A second session was held on Wednesday evening, July 1. The committee on Requirements for Graduation reported progress, but no definite results as yet, and was continued for a year.

PRACTICAL TECHNICAL EDUCATION.

The first of the professional papers was then taken up; a paper on "Engineering Education from the Point of View of the Practicing Engineer," by Mr. A. W. Ayer (Philadelphia, Pa.). The author premised that most of the positions under control of the practicing engineer are now occupied by graduates of engineering schools, and that in another generation we will likely see all such positions filled by engineering graduates. With this condition of things it seems important to fit these graduates as efficiently as possible for the work required of them. It is too often forgotten that engineering has its business side, and quite generally all business training is neglected in engineering education. There is a demand for engineers in business life. To fit them to meet this demand, teach them some of the business elements of engineering; give them a course in cost-keeping, and teach them to see not only labor cost and material cost, but also the highly important element of fixed charges, interest, depreciation and insurance. They should have courses in Specifications, the Law of Contracts, courses in History of Manufacture, and the like. There can be no doubt of the real need of these studies; the only question is, where can room for them be found. It would require a time of 3 hours per week for a period of a year and a-half to adequately cover the ground. The only way that appears is to omit some of the old-established courses of study which may be found less practically useful. A good plan is to seek the advice of alumni, whom the faculty would find valuable advisers in the choice of what studies to omit and what to insert.

There was much dissent from the recommendations of the paper, mainly on the grounds that there is no room for new courses, and that the addition of further short, disjointed courses would be detrimental. Prof. W. G. Raymond (Troy, N. Y.) doubted whether room could be found for the proposed work. Prof. C. F. Allen (Boston, Mass.) questioned whether undergraduates were in a position to get much comprehension of the subjects referred to, in the short time which could at best be afforded them. Prof. A. J. Wood (Newark, Del.) considered that the present-taught subject of Contracts and Specifications might easily be amplified by some exposition of business method, by getting business and professional men to lecture to the students. Similar ideas were expressed by Prof. A. N. Talbot (Urbana, Ill.) and Prof. H. Diemer (Lawrence, Kan.). Prof. C. M. Woodward (St. Louis, Mo.) stated that Washington University had last year given a course in Economics for Engineers in addition to the course in Contracts; he expressly opposed the putting of business into the class-room. Mr. L. Duncan (Ithaca, N. Y.) believed that financial and business principles come to the student instinctively; that the study of factory management would be of use to a very limited number; and that danger of crowding the curriculum counsels the avoidance of the special course recommended.

Prof. A. L. Williston (Brooklyn, N. Y.) was almost the sole defender of the author; he asked the pertinent question whether it is not as important for the mechanical engineer to know about insurance and methods of management as to be able to lay out tooth outlines. A later paper, by Prof. H. Diemer, dealt with the same matter in another form.

STUDENT GROUPS.

Under the title "Methods of Study for Technical Students," Prof. J. P. Jackson (State College, Pa.) offered a plea for a conscious effort on the part of the teacher to avoid any dogmatic effect and to cultivate the student's independence of thought. His special recommendation to this end was to encourage the students to meet, in congenial groups, for the free discussion of subjects studied or problems encountered. He has followed this plan for the past two years with most gratifying results. In discussion, question was raised by some as to whether this plan would reach the indifferent student, or whether it would be feasible in certain places (for instance in large cities), or whether it would succeed with all classes. It appeared from the testimony of several that the "group system" naturally exists among most student classes, and that the strong men were greatly helped thereby, while the poorest ones fall completely behind. However, it was stated that group working must be supplemented by work that is necessarily independent, and the suggestion was made that Professor Jackson had succeeded in pointing out to his students the right way of carrying on group work. Moreover, as Prof. W. M. Riggs (Clemson College, S. C.) made clear, a distinction must be made between the poor or dull student and the trifling one. The former is often much aided by group working, but for the latter there is no help.

PAPERS ON SPECIAL TOPICS.

The third session, held on the morning of Thursday, July 2, brought five papers, all interesting, but most of them treating rather special points in engineering education. Probably the most general was that of Prof. A. L. Williston (Brooklyn, N. Y.) on "Two Kinds of Specialization, and Fundamental Principles in Place and Out of Place." With a protest against the constant leaning of the Society in opposition to the idea of specialization in technical education, and against the sentiment that if certain academic and useless studies be omitted a man can be trained but not educated, the author classified specialization into that which is wise and good and that which is unwise and bad. The criterion for the latter is that uncoördinated short special courses are jumbled together in a curriculum, when thought and judgment are not exercised and when the subject is not connected with its fundamental principles; as a horrible example the author cited the courses in Chemical Engineering offered in some colleges. On the other hand, when you have a group of people who earnestly desire to acquire an education in a definite direction, then is the time to specialize in every way and as much as possible. Make the instruction in general subjects closely adapted to the end in view, and teach the special subjects thoroughly to get depth; but the teacher must be of proper caliber to be able to coördinate all subjects properly with the main special purpose. Prof. J. P. Jackson (State College, Pa.) maintained that the ground must be well plowed and harrowed before it is time to plant special teaching deeply in the mind; Prof. C. M. Woodward (St. Louis, Mo.) asserted that what the author had assumed is what the teacher does not know, viz., what direction the student will take later on. Professor Williston replied that the teacher in a vast number of cases does know, and that the place where the specialization should begin is in the secondary school, since in most cases the end of the primary school is the point where the boy's future course is decided. He advised that small institutions, which have not the means for deep special development in many or several branches, should take up one field for developing deeply, and should strive to acquire a reputation for thoroughness in that one field.

PREPARATION FOR FACTORY MANAGEMENT.

"Education Preparatory to Factory Management," by Prof. H. Diemer (Lawrence, Kan.), presented a definite program for some of the business training advocated in the previous paper by Mr. Ayer. Formerly the line of promotion in industrial business was from the clerk or stenographer to the high administrative positions; now, and still more in the future, the trained engineers are selected for these positions, for their sounder judgment and practical method of thought. Therefore the education of engineers should in some measure prepare for this. Many old standard courses of study have died away; thermodynamics

has only recently been rescued from unpractical abstruseness. More studies might be found that could be omitted or abridged. Instead of them, give training in business ideas, instil principles of cost-keeping into the student, give him an idea of shop-practice and business methods. Make the seniors the shop-foremen over the younger students, have them work out in detail the cost of one or two machines that are built in the shop. The discussion again brought up the recurring subject of where to find time for the proposed work. Prof. I. O. Baker (Urbana, Ill.) suggested that the students should take advantage of college appointments and duties to acquire some executive ability. Prof. A. L. Williston (Brooklyn, N. Y.) put the matter in the light of a necessary part of technical education. We must get to where we teach the whole truth about any one thing, and when we neglect the economic side of mechanical engineering we teach only part of the truth. The foremanship plan has been tried at Pratt Institute for the past four or five years, with excellent results. The author's recommendations were upheld also by Profs. C. S. Howe (Cleveland, O.), H. K. Vedder (Agricultural College, Mich.), and others. Prof. F. E. Turneaure (Madison, Wis.) suggested that the courses in Commerce at some universities might supply electives for the purpose desired; he pointed out, too, that business management is only part of what is required, that economics and sociology should also receive attention.

A paper by Prof. F. C. Caldwell (Columbus, O.) on "The Rating of Laboratory and Class-Room Work in Schedules of Courses" discussed the question of how much work to give the students and how to apportion the time equitably between different subjects, as affected by the rated equivalence of laboratory time and class-room time in the credit allowed for work. The paper and the discussion were, as is obvious, very technical and of little general interest. Prof. C. S. Howe (Cleveladn, O.) read a paper on "Practical Astronomy for Engineers," in which he urged that all courses in Civil Engineering include the study of Practical Astronomy. After presenting reasons for this, the author outlined what should be taught in this subject and how the instruction should be carried on. The paper was not discussed. Under the title "Engineering Jurisprudence an Essential in the Engineering Curriculum," Prof. A. H. Blanchard (Providence, R. I.) argued at some length that instruction in Engineering Jurisprudence be made a part of all egineering courses. He recommended that at least one hour per week for one year be devoted to the subject, and that an effort be made to have the work develop the students' legal judgment and argumentative powers. The discussion of the paper raised no question as to the advisability of giving such instruction, but rather urged that it be extended to mechanical and electrical engineering courses instead of being restricted to civil engineering. It was held that an engineer with legal training should give the course, rather than a lawyer. Prof. A. L. Williston (Brooklyn, N. Y.) quoted Mr. J. C. Wait, of New York, as saying that the average contract drawn by an engineer was a better and more accurate document than the contract drawn by a lawyer. Professor Williston doubted whether one hour per week for one year was enough time to give to the subject.

THE FATIGUE OF CEMENT.

An interesting communication by Prof. J. L. Van Ornum (St. Louis, Mo.) on fatigue of cement as shown by a series of tests marked the session of Thursday evening. In the course of the past year a series of over one hundred crushing tests on 2-in. molded blocks was carried out at Washington University, with a view to discovering the effect of repeated stress. The blocks were of neat cement, and the tests for failure under repeated load were made with successively lower percentages of the quiescent-load ultimate load. The curve of strength for varying numbers of repetitions thus obtained shows a remarkable similarity to the fatigue curves of iron and steel. As far as the limits of the tests permit of conclusions, the curve appears to be asymptotic to the line of about 50% of full strength. The whole matter will be presented before the American Society of Civil Engineers next fall.

Prof. W. M. Riggs (Clemson College, S. C.) showed a series of lantern slides illustrating the new electrical laboratory at the Agricultural and Mechanical College of South Carolina, and with their aid explained how the equipment is arranged to give the best teaching effect and yet allow of systematic conduct of the work. A number of features of the equipment are worth notice, for instance, the floor switchboards at each machine, and ceiling leads to the engine-room, the combination of the two allowing the most ready and obvious connections of machines, instruments, and accessories. The system has worked very satisfactorily during the past three or four years. A brief discussion of the paper touched mainly the question of permanent wiring. Prof. A. F. Ganz (Hoboken, N. J.) said that for some years past his aim had been to do away altogether with permanent wiring, bringing the (portable) machines to the place of test and running all wiring freely over the floor, so that the connections would be perfectly obvious. He has small portable switchboards which can be brought up to the machines for use. Students must pay for all apparatus damaged through carelessness, but in the past eight years only one ammeter has been burned out. Prof. F. C. Caldwell (Columbus, O.) put enclosed fuses on his instruments, and made students pay for all fuses blown. Professor Riggs, who also makes the students pay for damaged instruments, has had 25 or 30 burned out in the past ten years. The interesting fact was brought out that the mansion of Calhoun, the great Southerner, is directly adjacent to the laboratory described by Professor Riggs, and thus furnishes probably the most direct contrast between the old South and the new.

HISTORY OF ENGINEERING.

In the absence of the author, the secretary read a paper by Mr. J. A. L. Waddell (Kansas City, Mo.) on "The Advisability of Instructing Engineering Students in the History of the Engineering Profession," This brief paper, which we will reprint in a future issue, deplores in strong terms the lack of any instruction in, or even knowledge of, the history of the engineering profession, and then boldly suggests that the Society for the Promotion of Engineering Education undertake the compilation of a historical review of the development of engineering, classified by subject headings arranged alphabetically, and enriched by pictures of the prominent engineers of the past. The work is planned out in detail, and predictions made as to its success, as in the following two out of fifteen items:

(6) All papers should be written with the understanding that the main usefulness of the book will be through its perusal by students in technical schools.

(15) The sale of the book, even at the outset, would be immense; and afterwards the demand would be both large and constant, rendering the venture a financial success and the work the most popular and widely used of all engineering treatises:

A fat bundle of letters discussing the novel proposition was in the hands of the secretary. Nearly all of the writers expressed a commendatory opinion; the following are a few samples:

Major W. H. Bixby (Detroit, Mich.): Such a compilation would be very valuable; he would like to see the work done by the society.

Prof. D. Carhart (Allegheny, Pa.): There would be a great demand for the book. Its compilation would be discharge of a debt to the oldest profession.

Prof. M. Merriman (S. Bethlehem, Pa.): Not agreed that professors and students are "absolutely ignorant" of the history of their profession, nor that there is no book in this field. The compilation and sale of the book present a difficult financial problem. Cannot agree that its sale "would be immense." Thinks it not expedient for the society to take any action on the paper. If one or two historical papers were presented at each meeting of the society much good would be done.

Prof. S. N. Williams (Mt. Vernon, Ia.): Approves heartily of scheme. The modesty of engineers has hitherto kept them from presenting to the world their claims for recognition, but the time has come for remedy of this. He trusts steps will be taken at once to realize the proposed scheme, which he approves in detail.

Other letters were from Prof. B. F. Groat (Minneapolis, Minn.), Prof. P. C. Ricketts (Troy, N. Y.), Prof. E. W. Davis (Lincoln, Neb.), Mr. W. L. Miggett (Ann Arbor, Mich.), Prof. A. H. Fuller (Seattle, Wash.), Mr. W. G. Berg (New York, N. Y.), Mr. S. H. Moore (Kansas City, Mo.), Mr. E. L. Corthell (Great Barrington, Mass.), Prof. A. H. Nesbit (Durham, N. H.), Prof. F. H. Robinson (Newark, Del.), Prof. H. W. Tyler (Boston, Mass.), Prof. L. S. Randolph (Blacksburg, Va.), Prof. C. Puryear (College Sta., Texas), Prof. E. J. McCaustland (Ithaca, N. Y.), Prof. F. P. Spalding (Columbus, Mo.), and Mr. J. L. Harrington (New Brighton, N. Y.). Most of the expressions were very favorable, some doubted whether the Society should undertake the work, others again thought the suggestion excellent but impracticable. An attractive style was held to be a necessity, by some, Mr. E. L. Corthell offering Samuel Smiles as a model.

The oral discussion was not so plentiful. Prof. A. L. Williston (Brooklyn, N. Y.) thought that, while it is desirable to have more literature on engineering history, it would be very difficult to carry out the plan proposed. He thought it might be better for some technical publishing concern to take up the matter. He moved the appointment of a committee of three to consider the paper. Prof. J. P. Jackson (State College, Pa.) claimed that most professors do teach some enneering history, and most students acquire some knowledge of it; but practicing engineers often think they know better how to teach than do the teachers. He considered the proposed plan inadvisable and the proposed course of instruction much less important than many other courses which should be introduced. Notwithstanding, the motion for a committee was carried, and Profs. A. L. Williston (Brooklyn, N. Y.), W. G. Raymond (Troy, N. Y.), and Mansfield Merriman (South Bethlehem, Pa.), were appointed as committee.

The professional proceedings of the meeting closed by a joint session with the American Institute of Electrical Engineers on Friday morning; the proceedings at that session are briefly given in our report of the convention of the latter society.

Papers by Prof. S. H. Barraclough (Sydney, Australia) on "Progress of Technical Education in Australia," and Prof. W. H. Drane on "Engineering Education in the Southern States," were presented to the Society, but were read by title only.

By the close of the meeting the membership of the Society had reached the figure 336, some 20 to 30 new members having been admitted in the course of the meeting. The annual election of officers resulted as follows: President, Prof. C. F. Allen (Mass. Inst. of Technology); Vice-Presidents, Prof. C. L. Crandall (Cornell Univ.), and Prof. J. C. Nagle (Agric. and Mechan. Coll. of Texas); Secretary, Prof. C. A. Waldo (Purdue Univ.); Treasurer, Prof. A. N. Talbot (Univ. of Illinois).

Among the miscellaneous business of the meeting was the designation of Prof. T. C. Mendenhall as Honorary Member, the resolution to prepare a memoir on Prof. A. E. Fuertes, deceased, and the declaration of a vote of thanks to the American Institute of Electrical Engineers for its coöperation and the courtesies extended by it.

THE LOCOMOTIVE SHOPS of the Chicago, Milwaukee & St. Paul Ry. at West Milwaukee, Wis., are to be enlarged and extended with a view to providing better facilities for heavy repair work, and also facilities for building new engines. These are the main shops of the entire system, and freight cars have been built at the car shops for some years. It is proposed to establish locomotive shops with a capacity for building 75 new engines annually. A new power plant will supply steam power, and heating, also compressed air, and electric current for light and power, all machinery being operated by electricity, except that steam pumps will supply hydraulic power for the riveters. The erecting shop will be extended, and will have 25 pits. Work is now in progress, and about three years will be taken for its completion. The general scheme was prepared under the supervision of Mr. J. N. Barr, Assistant to the President, who is specially assigned to motive power matters. The work is under the direction of Mr. A. S. Manchester, Superintendent of Motive Power. In accordance with the usual practice of this company, it will design and erect its own buildings, this p of the work being in charge of Mr. C. F. Loweth, Engipart of the work being in charge of Mr. C. F. Loweth, Engineer and Superintendent of Bridges and Buildings.

ENGINEERING NEWS

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ADVERTISING RATES: 20 cents a line. "Want" and "For Sale" notices, special rates, see page XXIV-XXIX. New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.

The comparative merits of eye-bars and wire for the cables of the Manhattan suspension bridge over the East River at New York city have now been thoroughly discussed in these columns, as well as in the daily press, and notwithstanding the conflict of expert opinion, it appears to be well established that the bridge can be built with cables of either eye-bars or wire, and will be in either case a perfectly sound, safe and substantial structure. The point of chief divergence is on the relative cost of the two structures and the comparative time required for construction.

Under these circumstances the wise and safe course for the administration to pursue would seem to be to call for competitive bids on the two types of structure. There is the excellent business reason for taking this course that competition would thus be secured between the wire cable manufacturers and the makers of steel eye-bars. It is stated, we know, that there are several firms able to bid upon the wire cable work and that there are also at least three independent concerns able to bid for the eye-bars. Without disputing the truth of these assertions, we venture to suggest that it is also true that one concern has a large advantage over all others in bidding for wire cables and another concern has a large advantage over its competitors in bidding for the eye-bars. In order to secure the closest competition on the contracts for the bridge, therefore, the wire-maker and the eye-bar maker should be given a chance to bid against each other.

In all that has been said either by the Commissioner of Bridges or the Board of Experts in favor of the eye-bar structure, we fail to find any reason sufficiently weighty to justify the administration in shouldering the responsibility for this design, particularly since the matter has aroused so much controversy, and bids fair to become one of the issues in the approaching municipal election. It is not a question between good engineering and bad engineering, or between good government and bad government; if it were, Mayor Low and Commissioner Lindenthal would be justified in standing against all odds; but no such issues are pretended to be involved in the matter.

Why, then, should not the administration adopt a wholly impartial course in the matter and invite competitive bids on the two designs? Such a course would settle once for all the disputed question as to the relative cost of the two systems of construction, and would silence any possible charge of favoritism to either system. The city would be ensured of a first-rate bridge, whichever system was selected, and would get it at the lowest cost.

Of course the administration has the power to carry through its plans for the eye-bar bridge; but it is not always good policy to do what one has the power to do. There are clear-cut and positive issues on which the campaign for the fall election should be made, and to have these issues clouded by a discussion of eye-bars vs. wire and charges of favoritism in letting municipal contracts would be in the last degree unfortunate.

A society that is national in its scope and aims to cover an important field of work will from the nature of things have to deal with the diversified range of subjects. For handling these efficiently with regard both to the society and to each of the various special subjects it is obviously necessary to arrange for a concentrated and unified treatment. At the recent annual meeting of the Society for the Promotion of Engineering Education the respective advocates of general education and specialized instruction agreed on this point: that it is necessary, if special instruction is to be of any value, to continually connect it and coördinate it with its underlying general subject; time or effort split up and decentralized is worse than wasted because it also reacts injuriously on the already-developed faculties. These truths apply not only to abstract pedagogy, but also to the work of those other educators in the engineering field, our national societies of engineering. Unfortunately, they are entirely unrecognized in the management of most of these societies. Most of the latter, developed from small beginnings, have not adapted their methods to larger conditions. A technical club may discuss simultaneously many different subjects without much choice or arrangement; its main purpose is to keep alive the fires of enthusiasm and scientific curiosity in its members, and the reaching of exact and definite results is less essential. A national society should pursue other aims. Concentration and crystallization of diverging or straying endeavors must be its care. Without this it can at best be a great, sprawling, technical club, but it will not be truly a national engineering society, nor will it fulfil its proper obligations to its members and to the profession at large.

Among the half-dozen and more engineering societies which held their annual meetings during the past few weeks, nearly all might be censured in this regard. The American Institute of Electrical Engineers may be instanced as a notable offender. The program for its convention at Niagara Falls was literally choked up with papers. The condition of unhealthy overcrowding is indicated by the fact that some 25 or 30 technical papers (many of them lengthy and intricate) were scheduled, and that with five sessions on the regular program an added session became necessary to handle the papers. A week of convention, comprising six sessions, is from nearly every point of view too long; the energy which it consumes should be distributed through other portions of the year. But the convention in question failed in a further way; many of the papers were left nearly or entirely undiscussed, in some cases on account of lack of time, in other cases on account of lack of familiarity with the papers on the part of the audience. These conditions arose from the fact that most of the papers were in type only soon enough to be distributed at the convention, while some had not even reached this stage, and were read from manuscript. It was necessary, therefore, to read most of the papers in full, a proceeding wasteful of time; and, further, a concentrated or well-arranged discussion was not possible, since there is rarely much value in discussion based on a hasty perusal of a paper.

The fact is that even with such a plethora of papers there was, in the aggregate, a good deal of discussion, many single facts or observations, more or less exact in their nature, being thus communicated. But the recollection and orderly presentation of facts and conclusions pertinent to a given subject requires time and must be done in that place where the facts, results and records are available for collation; that is to say, a discussion should be prepared in the engineer's study, previous to the convention, rather than that it should spring from thoughts suddenly conceived on the convention floor. The discussion at Niagara Falls was largely a rambling mixture of opinion and observation, which pointed to no definite conclusions, could not properly coördinate itself with the subject in hand, and was therefore to a great extent wasted effort.

In order that the preceding comment may not give false impressions, however, it is proper to say that the convention of the American Institute of Electrical Engineers was a success as a convention. The large roll of attendance alone gives evidence of that. A gratifying feature was the way in which the committee on High-Tension Transmission came before the society-at-large for aid in the line of discussion. Various matters which formed central points in the work of that committee were discussed in a series of eight essays by competent engineers; these essays were printed and distributed to the membership some weeks before the convention, with an invitation for written discussion of any or all of the detail matters involved. It was desired to get the conclusions of practical experience, and the observed facts on which other conclusions might be based, for the purpose of making the work of the committee as efficient and valuable as possible. Too often committee reports represent accurately the personal views of the committee-members only, while in many cases they are purely one-man reports. The most effective committee work would be that which combines the respective advantages of a one-man committee and of a committee of the whole. The course which the committee presided over by Mr. R. D. Mershon has adopted seems adapted to secure nearly such results.

The wear of centrifugal pump casings, where sand or silt is pumped, becomes a matter of great importance to a contractor for three reasons; first, because a time is ultimately reached when the pump must go out of commission for repairs, during which time a centrifugal pump dredge, for example, is idle; second, because of the money actually paid out for repairs; and third, because of the decreased efficiency of a centrifugal pump after it has become somewhat worn. Contractors are undoubtedly awake to the importance of the first two items of cost, but we question whether many have given any thought to the third. Low efficiency of a pump of course means a big coal bill.

We publish in this issue a very interesting and instructive article entitled "An Improved Centrifugal Dredging Pump," and in that article will be found the surprising but undeniable fact that wear on the casing of a centrifugal pump may reduce its efficiency by 50%!

In the paper just mentioned there is another very interesting and instructive fact brought out. We refer to the material to be used in lining a centrifugal pump that is handling sand, or silt. A table is given showing that, of the materials tested, boiler plate is the most effective. The surprisingly slow rate of wear of such soft materials as lead and copper is worth attention. We would suggest that as nickel-steel rails are coming into use because of their durability that perhaps nickel-steel plates would make an excellent lining for such pumps. It is stated that a two-inch thick cast iron casing of a centrifugal pump dredger wore through in 100 days of 10 working hours each.

SOME HINTS ON MAKING CONCRETE COPING.

The great number of concrete retaining walls now building make the question of coping design and coping construction one of importance.

On masonry walls coping serves two purposes: (1) It sheds rain water and prevents the saturation of the backing, which is more or less porous; (2) it improves the looks of the wall, relieving it of the "bobtailed" appearance that it has when uncoped. With the passing of the masonry wall coping has left to it only the aesthetic function.

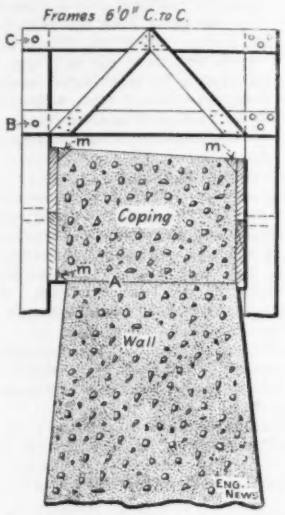


Fig. 1. End View of Concrete Coping Frame.

In performing this function we have of course to consider the matter of cost. It is our purpose to briefly indicate how a good-looking and at the same time inexpensive concrete coping may be made.

In the first place, since concrete is more fragile than stone, it should be beveled or rounded on the exposed edges. Rounding may be done by a special tool while the mortar is still soft, but a more satisfactory way, perhaps, is to bevel the edges, which is done by fastening molding of triangular cross-section to the frames or "molds" in which the concrete is deposited. In Fig. 1 triangular molding strips, M, are shown nailed to the 1½ or 2-in. planks that form the front and rear faces of the coping.

In building a concrete wall it is ordinarily best to build the wall up to the line, AA, underneath the proposed coping; let the concrete harden and remove the frames. Then mount the special coping frame, Fig. 1, on the wall and fill it with concrete. Thus the main wall may be built with machine-mixed concrete, while the coping is hand-mixed and placed with more care. Ordinarily a heavy and cumbersome framing is used by contractors on coping, and it is torn to pieces when the coping has set. The design of framing shown in Fig. 1 is a slight modification of the design described by Mr. H. P. Gillette in Engineering News Dec. 5, 1901. It possesses the merit of being light and simple, and the same frames can be used again and again, thus saving the very expensive item of frame making. In building a 12-ft. section of coping one end of the frame rests upon the end

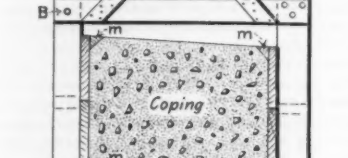


Fig. 2. Front View of Concrete Coping with Beveled Edges.

of the previously-built section, while the other end is supported by blocking on the wall itself.

In order to cover up the unsightly seam that would occur where new concrete is built on to old, cross-strips of triangular molding are nailed to the frames so as to produce deeply-beveled, vertical and horizontal joints in the coping, as in Fig. 2. This adds very materially to the appearance of the wall by breaking up the monotony of the one long smooth face that otherwise would be had. To remove the frame, when the coping has hardened, it is only necessary to take out the bolts, B and C, and lift the two parts of the frame away from the wall.

As regards the material of which the coping concrete is made, it may be the same as the body of the wall, but the front face and top of coping for a depth of 2 to 3 ins. should be Portland cement mortar, 1 to 2, the top being "floated," as in making cement sidewalks, by skilled men.

The thickness of the coping should vary somewhat with the size of the wall, 12 to 16 ins. for walls, say, 15 ft. high.

Finally, one more little hint: Slope the top of the coping backward from the front face, so as to shed rain water over the rear of the wall. Otherwise rain water will wash the dust and cinders down over the face of the wall and stain it. This is a small, but important point if one would preserve the neat appearance of a concrete face. Any water thus diverted to the earth back of the wall adds very little to the water that will be there anyway, and in cases where earth saturation will be very objectionable weep-holes at the base of the wall may be provided. Weep-holes are seldom needed, however, for few retaining walls are so long or so placed as to prevent escape of water lengthwise along the back of the wall. And as a matter of fact, if open-drain tiling were laid along the back of the wall it would serve far better than occasional weep-holes through the wall.

Regarding the facing mortar, we incline to the opinion that engineers will eventually add iron oxide or other coloring matter to secure a change from what promises to become a very monotonous gray—the gray of Portland cement. Even if the coping were the only part of the wall so colored it would be a decided relief. We recall seeing a concrete wall coped with red Medina sandstone that gave a very pleasing effect, and the very same effect could be readily given to concrete coping by the use of a little iron oxide in the face and top mortar.

LETTERS TO THE EDITOR.

Another Account of the Failure of a Steel Viaduct at Minneapolis, Minn.

Sir: The report of the "Failure of a Steel Viaduct at Minneapolis, Minn.," published in your issue of June 25, is in error when it states that the collapse occurred immediately after the passage of a heavy trolley car. A gentleman employed in the Minneapolis office of the American Bridge Co. was an occupant of the car in question, and his experience was much more thrilling than your account would indicate.

A westbound car, 43 ft. long, weighing 21 tons, and with about 15 passengers, was reducing speed to stop at the Union Station. The track began to sink, apparently under the front truck, and the motorman threw off the brakes and turned on full power. As the car gained speed the rear truck sank a foot or more, accompanied by a total collapse of a section of viaduct about 30 ft. square, leaving only the rails and ties spanning the opening. The rear truck kept the rails and rose to level track in safety.

The rails were of standard section, 80 lbs. per yd., and 60 ft. long, with cast-welded joints. The rails showed a permanent deflection of about 1 ft., while those of the other track were probably not more than 2 ins. below their former position. Temporary wooden supports and a plank platform soon permitted the resumption of traffic, but in bringing the track to its former level, the elongation of the rails necessitated a lateral deflection of several inches.

That the car escaped a plunge into the wreck below was no doubt due to the fact that when the viaduct collapsed, there was a suspension bridge of steel rails to fall back on. Yours very truly,

E. F. Pabody, Jr., Contracting Agent,
American Bridge Co. of New York.

Seventh Ave. and 2d St., S. E., Minneapolis, Minn.,
June 29 1903.

The Resistance of Concrete to Heat.

Sir: Some weeks ago you took occasion in your editorial columns to call attention to some remarkable statements made in the publication called "Fire Proof." A May number of this publication has recently come to the writer's notice. Articles in this publication attempt to show that cement used in concrete for fireproofing is not fireproof when compared with burnt clay blocks used for similar purposes. The statement is made in several places that concrete is not fireproof, yet no data is given to substantiate this statement, except the following clause:

If it is fireproof, why are not the kilns in which cement used in concrete manufacture built of concrete? In plain truth, those same kilns in which cement is manufactured are built of clay, because burnt clay is fireproof; cement is not.

In the Portland cement plants that have been erected in the past seven or eight years none of the kilns are built of burnt clay. The kilns are built of steel, and although they have a lining of firebrick it does not come in direct contact with the fire without being damaged. This firebrick is made of clay containing the highest per cent. of alumina possible to procure. Then to operate the kiln commercially there must be fused on to this firebrick lining a heavy coating of cement before the kiln will stand the temperature to clinker first-class Portland cement. The clay which is used, however, for making this firebrick is entirely different from that used in manufacturing clay blocks for fireproof purposes. The clay that is used for fireproofing would not stand the temperature in a cement kiln for two hours, and even the high aluminite firebrick which comes between the cement lining and the steel shell of the kiln would be burnt through in from 24 to 48 hours if the fire played directly upon it as it does on the cement lining. Some manufacturers have used an entire lining of the cement brick; but it has been found better to line the kilns with 6 ins. of high aluminite firebrick and then burn a lining of 6 to 8 ins. of cement on the face of the firebrick. When this operation is completed the kiln will run, without being relined, from 6 to 18 months, depending on the skill of the burner in charge. There is not a burnt clay product on the market that will stand the temperature used in a cement kiln, unless it is covered with a thick cement lining.

It is a well-known fact that in the most severe fires where the fireproofing has been made of concrete the floors have stood under their load, and where the fireproofing has been made of burnt clay blocks, the floors have collapsed. These results are due to the concrete not breaking from the expansion caused by the heat, whereas the expansion breaks the burnt clay blocks.

Yours truly, Wm. G. Hartranft.

Craigsville, Va., July 3, 1903.

Tests of Boilers and Furnace Efficiencies.

Sir: Referring to the abstract of my paper read before the National Electric Light Association, as published in your issue of June 11, (p. 521), it may be useful to direct attention to the reason for the difference in efficiency between the standard form of the Heine boiler, and the boiler as improved by the extended length of gas travel. The accompanying diagram shows the temperature of the gases existing at the front end of the standard boiler, the measurements are on a line 45 ins. back from the water leg. The temperatures shown at the first and second staybolts are influenced by heat from the tile roof of the

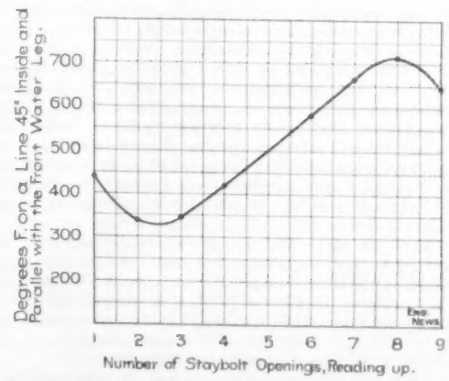


Diagram Plotted from Temperature Measurements of Gases Leaving Front End of Standard Heine Boiler.

furnace. The measurements above these however, give the temperature of the moving gas volume, and this is shown as increasing as the outlet is approached, so that the point of highest temperature of the curve is where the gases leave the tubes of the boiler. This is because the travel of the gases is from the back lower to the front upper corner; consequently the front lower corner remains cool, and performs but little work on the line of 45 ins. from the water leg, and the work that is performed is at the top of this line. A similar condition existed at the back upper corner, but on a somewhat reduced scale.

One of the most striking features in connection with these boilers which are designated as Nos. 1 and 2 (standard form of Heine boiler) is that they could have been shorter. In other words, 3 ft. could be cut off from the front end without affecting their capacity or efficiency, and the investment for this additional 3 ft. of boiler, and the additional building and ground required to accommodate it, was useless.

The improvement of the lengthened gas travel which utilized all of the heating surface, and secured a greater cooling effect with these Heine boilers was devised by Mr. W. L. Abbott and myself for the purpose of increasing the efficiency of the boiler plant in which they are located. I am unable to learn of the scheme having been previously adopted, although the makers of this boiler state that it has been considered.

In the original paper the boilers not being referred to by name it may be well to say that the Babcock & Wilcox was designated as A. The Heine boilers tested without improved gas travel were designated as Nos. 1 and 2, and the improvement as No. 3. Very truly yours,

A. Bement.

218 La Salle St., Chicago, June 20, 1903.

The Board of Experts' Report on Eye-Bar Cables for the Manhattan Bridge.

Sir: When it was announced in the papers that the five experts, appointed by the Mayor for passing on Mr. Lindenthal's Manhattan bridge plans, had reported unanimously in favor of eye-bar chains, the writer's revised comparison between eye-bar chains and wire cables was already set in type for the Engineering News of July 2, else he would have added some remarks on the decision of the experts. Before reading the report of the Commission, the writer attributed its unanmious decision to the unanimous mind and qualities of the experts who constituted the Commission. They are all skilled engineers in the same class of work in which eye-bars used to be extensively applied, and none of them has any experience in the construction of suspension bridges. The final report, as published in the Engineering News of July 2, is even more disappointing than the preliminary report. It is altogether so non-committal and spiritless that it is to be wondered whether the Mayor will consider it worth the money it has cost. There are no arguments or comparisons; the question of economy (the most important to the public) is not even mentioned; for explanations and for the motives which led to the final decision, the Commission refers to the preliminary report, published March 12. Unfortunately this preliminary report also does not give satisfactory explanations.

The substance of the two reports together can be condensed to the following two sentences:

1. It is possible to build a bridge over the East River on Mr. Lindenthal's plan.

2. It is possible to manufacture, at a reasonable price, steel which in small test pieces shows a tenacity of 85,000 lbs. and an elastic limit of 48,000 lbs. per sq. in.

On the second insignificant fact the experts base their decision, and recommend to the Mayor the expenditure of ten and a half millions of public money! That the proposed bridge is experimental in many respects and that the experts are not certain of its ultimate success, as an economical structure, is proven in every sentence of both reports.

They do not assert (because they don't know) that large eye-bars can be made of the qualities as mentioned above, but they say that such eye-bars would be "satisfactory" to them. They know, however, that there is a great difference in the qualities of test pieces and of full-sized bars. If they don't know it, they can learn from Mr. Henning's article in the Engineering News of July 2, that full-sized eye-bars, made of a steel with 70,000 lbs. per sq. in. tenacity, show a tenacity of only 54,600 lbs. In the same proportion, the great eye-bars, as proposed for the Manhattan bridge, would have a tenacity of less than 66,000 lbs. per sq. in. Would that be satisfactory to the experts?

One would think that the experts would say that the tests made by "themselves" had given "conclusive proofs beyond the shadow of a doubt" that the desired eye-bars can be made. In place of that, they meekly say: "The tests so far made *would indicate* that the above results can be obtained with a steel of certain compositions."

What were those tests and who made them?

We are not informed as to this, but the experts simply state that the tests were "submitted" to them.

Turning to the comparison between eye-bar chains and wire cables, the experts say in the preliminary report: "The chains have decided advantages in the accessibility of all parts for inspection, as well as in economy and rapidity of erection." If both arguments were true, is this worth three and a half millions of dollars? Of all advantages a chain "might" have the experts have chosen to mention one of which they know nothing by actual experience.

The report goes on: "Chains are to be preferred to wire cables whenever the cost of the chains is not materially greater." Why are the chains to be preferred? It is not stated. This chapter of the preliminary report ends with: 'The cost of eye-bar chains and wire cables in this bridge would be about the same." Had the experts any data to base a correct calculation on when that assertion was made? No. At that time they did not even have tests made; they did not know whether the desired steel could be made and at what cost; they did not know, and don't know yet, whether eye-bars can be made of the desired qualities. Still, they boldly assert that the cost would be "about" the same, based on nothing except on a rough guess! What value has such a guess as an argument? In opposition to this guess there are the indisputable calculations of the writer who "proves" that eye-bars will cost about three and a half millions more than wire cables! Mr. Lindenthal himself corroborates this calculation, by asking from the Aldermen three millions and a half more money than what the same work has cost at the Williamsburg bridge!

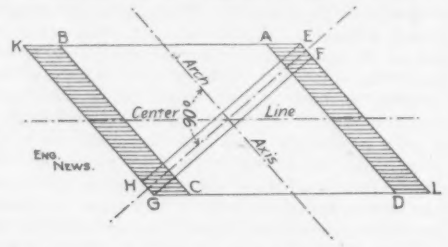
That the experts are all engineers of high professional standing does not alter the facts and figures, nor does it make the weak points in their report stronger! It merely emphasizes the weakness.

Wilhelm Hildenbrand, C. E.

New York, July 6, 1903.

The Theory of Skew Arches.

Sir: The discussion of skew arches by Mr. W. C. Kernot in the Engineering News of June 11, has just come to my attention, and aroused my interest. I have never built, designed, or even studied the skew arch, either in college or elsewhere, but would like to indicate what seems to me to be the proper method of going into the safe and economical design of this kind of a structure, and an explanation of what Mr. Kernot finds to be true regarding the location and direction of maximum stresses. In the first place, it appears wrong to assume that



any section or lamina (imaginary slice, however thin) of a skew arch taken longitudinally, parallel to either face, is the same as a section or lamina of a symmetrical arch. It certainly is not. In general, a skew arch appears to me as containing a simple, or symmetrical arch, as indicated in the following figure, the portion H E F G, which can only be obtained, or seen, when the section considered be taken at right angles to the axis, or the straight-line elements of the arch ring, and cuts both abutments, as shown. Now, this portion H E F G is evidently the dangerous section, for it must carry not only the loads coming upon it, but must partially support by vertical and horizontal shear, in the sections H E and G F, the loads coming upon the parts G F L and K E H.

According to mechanics, we should consider the skew arch bridge as made up of the parts H E F G and G F L and K E H, and consider each separately as a free body, supplying as external forces the reactions of the adjacent portion or portions, the foundation, backing of abutments, loads, etc., and determine what the reactions of K E H or G F L is upon H E F G. Then design H E F G to resist its own loading and these reactions.

Any other section made at right angles to the arch axis and outside the portion H E F G will have less and less stresses transmitted across itself as that section approaches the points K and L, less stresses in the abutments here, as shown by Mr. Kernot, and of course, a less thickness of abutment required.

It is surprising that skew arch abutments have been built in the old form until this day, instead of the form recommended by the aforenamed writer.

W. E. Miller,
Transitman with Pennsylvania R. R. Co.

Pittsburg, Pa., June 24, 1903.

Stresses in Skew Arches.

Sir: In Engineering News of June 11, there is an interesting discussion of the skew arch design by Professor Kernot. It seems that the inequality of stresses as there shown in a mechanical way can also be proven analytically, and an approximately true method of designing the arch given:

In Fig. 1, let the arch ring be divided in curved wedge elements bounded by planes shown in plan by the lines A B, A C, etc. We can imagine these arch elements as a series of horizontal beams or better still, as king-post trusses with the horizontal members omitted. This will not change the amount of the stresses reaching the abutments. The stresses of the load on the structure and the reactions from the abutments must go in the directions of these lines as shown respectively by the arrows L and R.

In the case of the arch, these stresses will produce a shear between the elements bounded by these lines A B, etc., and the unit shear in any radial plane, parallel to the axis as s s, will decrease from S towards s, as the elements, starting from the face of the arch decrease in area going towards A V.

Also the unit shear and compression in these radial planes will decrease moving from A towards the other abutment. These load stresses will not all go (as indicated) to the point A, but will be distributed on the abutment from A towards B by the internal resisting shears. Theoretically this shear will be zero when we reach an element which lies at right angles with the planes of the face walls, and the abutment between the point A and some point toward B must carry all the loads transmitted through the oblique elements.

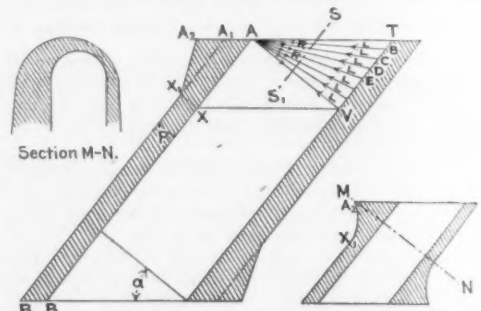
We may now draw a typical section of the arch ring in the plane of the springing line (see Fig. 2)—but we do not know whether $A_2 x$, will be a concave, a convex, or a straight line; it will vary so little from a straight line that either waste of masonry or loss of strength will be of little consequence.

A practical way to design the arch would be to determine the thickness of the arch ring and abutment at the springing line at the point P by the methods in use for designing right arches. Then considering the triangular portion A V T, in Fig. 1, if the arch was symmetrical the centre of gravity of its loads would be approximately two-thirds of the span distant from A towards the other abutment; but as the ring is heavier on the side next A, let us consider the resultant of the loading to be in the center of the span.

The increase of the load on A due to the triangular part of the arch can then be found approximately by taking moments around V T. Suppose this will require the additional thickness, $A_1 A_2$. Then A A_2 is the thickness of the abutment and arch on the springing line. This dimension of A A_2 may require a new position for the resultant of the loads on the triangular part. We can then take moments a second time which will give a dimension for A_1 A_2 near enough for the purpose.

To locate X: Lay off the distance T V = span by tangent a, from A toward B and draw A_2 A and B B_1 X_1 A^2 A will be a section of the abutment and arch ring at the springing line.

Another method to locate A_2 would be to consider the span as A T and design the abutment at A by usual methods. The writer will admit there is not much mathematical basis for this method of locating X, but it is one



of those cases which Trautwine speaks of (on another subject) as a "Coefficient according to judgment." (It has this foundation in reason, however, that the greater the skew the longer will be the line A X, and this is as it should be).

Professor Kernot's method of re-inforcing the abutment at A by building the end wall along the diagonal, as shown in his figure, would probably be the better plan from a purely engineering point of view, but the structure would have a bad appearance, especially if parapet walls were carried up, as would be the case in city bridges.

In this connection, Mr. Editor, I wish to express my admiration for the great aid the modern engineering journal is to the profession. Professor Kernot's paper on the failure of an arch and the experiments afterwards made throw more light on the subject of skew arches than is contained in existing text books. Indeed the paper in question totally disproves the theory on this subject of one whose work is a classic in engineering literature. It is unfortunate the account did not give the length of span, thickness of arch, manner of loading, etc.

Yours truly,

J. A. Paige, Assistant Engineer.

City Engineers' Office, Baltimore, Md., June 15, 1903.

Notes and Queries.

L. R. M., San Francisco, Cal., asks if any effort has ever been made to organize the U. S. Assistant Engineers, doing river, harbor and fortification work under the War Department, into a separate organization similar in form to the Civil Engineer Corps of the U. S. Navy. Can any of our readers make answer?

S. wishes to know of some simple means of rapidly unloading gravel from two or three flat cars, apparatus for which could be constructed by a carpenter.

A FIRE-PROTECTION WATER SUPPLY system, under high pressure, has been recommended for Chicago by the commission appointed last year to consider the matter, as reported in our issue of Sept. 25, 1902. The commission advises that the city commence at once the gradual installation of the system, and suggests that for

this purpose the city be divided into districts including closely-built business and manufacturing localities. The cost is estimated at $1,000,000, which amount it is proposed to raise by the issue of water certificates, and these the business men are expected to take up. The commission submitted with its report a proposed ordinance, which has been sent to the finance committee for consideration. This ordinance creates an advisory commission to act for two years and take charge of the installation of the system. The commission consists of representatives of six business organizations and interests and three aldermen, appointed by the mayor. The ordinance provides for the appointment of an hydraulic engineer at a salary of $500 a month. The fire marshal and commissioner of public works are to be ex-officio members of the commission. This commission is requested to define the limits of high pressure districts, make plans for the systems, and ascertain where the mains are most needed. The hydraulic engineer is to be selected by the commission and act under its direction, prepare plans and specifications for the system, and supervise its construction. The first installation will comprise pumping stations, circulating mains, and such branches as cannot be delayed without danger of undue loss of property by fire. New districts may be established upon the petition of fifty property owners concerned and affirmative action by the city council.

ELECTRIC LOCOMOBILES have been superseded by motor cars on the Central London Ry. as a result of the recent investigations into the cause of the serious vibrations felt in neighboring buildings due to the operation of traffic on this underground railway.

THE MAKING OF SPECIFICATIONS.*

By Dr. Chas. B. Dudley.†

What has a society devoted to the testing of materials to do with the making of specifications? Should not methods of testing and the finding out of the various properties of materials which render them valuable and useful be its legitimate field of study, rather than the assembling or combining of these various properties in the form of specifications? Should not the work of making specifications be undertaken by the engineers or the parties interested in any case? If we undesrtand the matter rightly, this is the view taken by many of the leaders of the International Association, with which we are affiliated. In this country on the contrary, we have taken what may be called the "broader view."

We have failed to think of an argument in favor of making methods of testing the legitimate work of such a society of ours, which does not equally justify the making of specifications for materials a part of that legitimate work.

It has occurred to us that it might be useful and valuable to give an exposè somewhat in detail of the methods practiced at Altoona, in connection with the laboratory of the Pennsylvania Railroad, in making specifications.

The general plan which we have at Altoona is as follows: First, we try to find out what we want. Some difficulty arises in the services; some parts of construction fail, and an investigation is made to see if the cause of the failure can be located, or some product which is being largely used and which is being furnished by different makers, is believed not to be of equal quality from the different sources, or indeed, it is desired to standardize a practice and make it uniform all over the road, and as an element in this problem, the same quality of material must be furnished and used. These and other elements lead us to make investigations into the nature of the commercial products involved. These investigations lead to specifications.

The specifications after being made are placed in the hands of the Purchasing Agent, and by him are made a part of the contract on which the materials are bought. Shipments of material in accordance with this contract being received, each shipment or specified definite amount is sampled, and the samples examined in accordance with the specifications. If the samples stand test, the material is accepted and paid for; if not, the material is rejected and returned to the makers.

This plan has been in daily use at Altoona, in connection with the Pennsylvania Railroad, for something over 20 years. The number of specifications, both physical and chemical is 47.

At first our specifications considered almost exclusively the two principal parties involved, namely, the producer and the consumer, but as time progressed questions began to arise as to how much material should be involved in one test. Then came the question, would it be advisable to buy in lots of the same size as the test involves? Then came the question of sampling. Then came the question, shall part of the work of deciding whether shipments fill the requirements be done at the works where the material is made, or shall it all be done after the shipment is received? If the former, an inspector is involved; and he must have information which could perhaps best be embodied in the specification itself. Furthermore, those who actually applied the tests, the chemist and the engineer of tests, would frequently ask questions in regard to methods, or interpretations of various points, and, finally, it was found that those who ultimately received the material, such as the storekeeper or shop foreman, could frequently make certain inspections, better perhaps, and cheaper than any one else, and so information must be furnished for them.

This necessity for information for the use of a number of different parties, has made the modern fairly workable specification for certain materials, to be a somewhat lengthy and at times a seemingly cumbrous affair. It is difficult to draw the line as to exactly what should be included and what excluded in a specification. The commercial interests of the manufacturer on one side, and the zeal, sometimes excessive it must be confessed, on the other side, on the part of the inspector, or chemist or engineer of tests, led to very close scrutiny of the wording of the specification, and it cannot be denied that many times conditions arise which make those who are deciding the fate of shipments, wish that the specification had been more minutely drawn.

In drawing a specification, one is always between two fires—the fear of making a specification too cumbrous and unwieldy, and fear of leaving out something which will be found desirable or even essential a little later. As far as we can be said to have reached a positive conclusion at Altoona, it may perhaps be embodied in this, that a good workable specification should contain such information as is needed by the purchasing agent, such information as is needed by the manufacturer, by the inspector, by the chemist, by the engineer of tests, and by the people who are to receive and use the material.

It may not be amiss at this point to state that in view of the difficulties connected with discrepancies in chemical analyses, we began several years ago,to print and issue in separate form, the methods used in our laboratory, making these methods a part of the specifications by reference only, and thus also a part of the contract. The same practice has prevailed elsewhere in regard to methods of physical testing, and it is our sincere hope that sooner or later, our Society will issue in printed form, what it recognizes as standard methods of testing. Such work well and carefully done, will relieve specifications of much which they must now necessarily contain.

A fault which characterizes many specifications, is the attempt on the part of the one who draws the specification, to make it a place to show how much he knows. The folly of this is apparent.

Another fault is in putting too many restrictions into the specifications. According to our views, the fewer possible restrictions that a specification can contain, and at the same time afford the necessary protection in regard to the quality of the material, the better the specification is. In some of our specifications we have only one test; in others perhaps half a dozen; the effort, however, being always to have the minimum number which will yield the product that is required.

A third fault in specifications is in making the limits too severe. Some writers who draw specifications apparently put themselves in position of absolute antagonism to those who are to make the material,and seem to have as a permanent thought in their minds, to tie them down to the extreme limit. The maximum that a single test piece shows, the minimum of an objectionable constituent that may be obtained by analysis, the extreme point in elongation that by chance some good and exceptional sample gives, are made to represent the total output of the works.

It is perhaps needless to say that such extreme figures are the worst possible mistake in making specifications. The success or failure of structures or of material in service, does not depend on such extreme figures. It is infinitely better to specify a good average material, and get the necessary protection in structures by a more liberal factor of safety in the design, than to insist on such extreme limits, which can only lead to constant friction, and demand for concessions at the penalty of delaying the work.

It may be interesting to know something of the routine leading to a complete specification, in our work at Altoona. The first step in the process is the accumulation of information. This we obtain from any available sources. Sometimes we get samples from the service which have given both good results and bad results, a sufficient number being obtained, to get a reasonable average, and make of these samples careful analyses and physical tests.

Again, direct, positive experiments are made, sometimes on a fairly large scale. The experiments leading up to the thermal test for cast-iron wheels, involved the testing of some 200 wheels, representing as many kinds of wheels as could be obtained. These wheels were all tested thermally, and a complete record made of their behavior. By far the largest portion of them were then likewise analyzed, to see whether chemistry would throw any light on the problem. In the work leading to the specifications for axles, some two or three years were involved in the accumulation of the information. Every broken axle that failed in service, for a long time was carefully analyzed and physical tests made. It is, of course, recognized that the possibilities of the material must be considered; nothing must be specified beyond what the material will reasonably give. Again in the accumulation of our material leading to a specification, it is usually customary to pay a visit to the parties who make the materials involved, and learn from them as far as possible, what their materials will give. A more or less intimate knowledge of the methods used in the manufacture of the constituents which enter into the finished product, and of the properties of each, we deem an essential pre-requisite to the drawing of a specification. Finally, the experiences of the practical man as to the behavior and characteristics of materials which have been used for years, are made use of. Other specifications, printed matter of all kinds, of which there is now such an abundance, proceedings of technical societies, investigations made and published by engineers, etc., are drawn upon whenever possible.

It will be readily understood that this accumulation of information in the case of important specifications takes much time. Some materials have been under study for ten years or more, and no specification has yet resulted. Other subjects are simpler and the specifications can be made in a few weeks. Not a few of our specifications at Altoona,represent two or three years' work in the accumulation of information, before it is ever put in shape.

The material having been accumulated, is digested, and some one of us puts it into the form of a specification. It is a great temptation and a common error to put into the first draft of a specification, too much. It must be remembered when making a specification for a material which has hitherto not been subjected to test, that the manufacturer is more or less uncertain as to his product, and that it may require on his part, changes in methods, and possibly in materials entering into his product, in order to meet the requirements of the specifications. If now too much is put into the first draft, the inevitable result will be that undue difficulties will be introduced in the manufacture, and the consumer will not infrequently find himself without the possibility of supplying his wants in the market. It is infinitely better to make the first draft of a specification embody only a few essential points, and after such changes in the works have been made as enable the manufacturer to meet these requirements, to revise the specification, embodying more. A not inappropriate illustration of this point may be found in the drop test for car wheels. Although the car wheels made at Altoona many years ago, would stand the drop test specified up to 15 or 20 blows without breaking, the first specification for drop test of car wheels which was put out, was limited to three blows of the same drop, and it was with difficulty that wheels were obtained even under this test. In the course of a few months, however, the test was easily met, and was even made more rigid, and ultimately reached a limit of eight blows.

To return now to the specification: As previously stated, the material is put into shape by some one of us at Altoona. Then a conference is called, consisting of the mechanical engineer, the engineer of tests, the chemist and the general superintendent of motive power, under whose supervision, according to the organization of the Pennsylvania Railroad Company, all tests and experiments are made. The specification as drawn is carefully read over and criticised. As the result of this criticism it is redrawn, and then the material is put in print, copies of the print being sent to the purchasing agent and to each of the superintendents of motive power of the system. Along with the printed copy goes a request to each of the superintendents of motive power to criticise the specification on his own part and submit it to his master mechanic or to those of his subordinates who may use the material and may be competent to criticise. To the purchasing agent the request is made that he shall submit the specification to all those manufacturers of the material involved from whom he desires to buy, with request for the freest possible criticism from their standpoints.

The criticism from the service through the superintendents of motive power many times yields valuable suggestions. The criticisms from the manufacturers have been the result of some very peculiar and interesting episodes. Some of the manufacturers apparently fearing that their criticisms may affect the placing of orders, content themselves by saying that they can meet the specifications as well as any one, and that they should be glad to have orders in accordance with them. Others take the occasion to bring forward characteristics of their own products. For example, in criticising a proposed specification for petroleum products at one time, one manufacturer desired a clause introduced that only Pennsylvania petroleum should be used. At one time in the criticism of a proposed specification for rails, information was developed seeming to indicate that the effect of certain constituents on steel was a question of geography; thus: the manufacturers east of the Susquehanna River brought forth the statement that sulphur and copper were not injurious to steel, but that phosphorus was its bane, while the manufacturers west of Pittsburg brought forth the equally remarkable statement that phosphorus did not do much damage to steel, but that sulphur and copper were most injurious to it. Those

*Slightly condensed from the Presidential address delivered before the American Society for Testing Materials, at its annual meeting.

†Chief Chemist; Pennsylvania R. R., Altoona, Pa.

who were located between those two points practically said we will give you whatever you pay for. Some manufacturers, however, in criticising specifications, apparently size up the situation and give honest and valuable suggestions.

We regard this submission of specifications to the manufacturers before it is issued as a matter of the utmost importance. In the early days our idea was, as already stated, to tell the manufacturers what we wanted. We were the parties to define the material, and it was their part to simply give us what we asked for. At the present time our idea is that the specification should be the embodiment of the best that is known on the subject, no matter where the information comes from, and that we are not only foolish but short-sighted and unfair if we attempt to make a specification without at least giving the manufacturers an opportunity to co-operate. We feel that the specification should be regarded as partly his creation as well as ours, and that he should be able to see his own handiwork in it. We are free to put on record that to the co-operation and help of the manufacturers of materials quite a portion of the success, if any, that has attended the Pennsylvania Railroad specifications has been due.

The criticisms from all sources having been received, the specification is carefully gone over again in the light of these criticisms. As far as possible the valid and valuable suggestions of all are embodied. Conflicting criticisms, many times due to local conditions, are harmonized as well as may be, and the specification as redrawn and modified is then submitted to the proper officers for approval, and ultimately issued and made a part of the contract on which materials are furnished, as has already been described.

So much may be said on this subject that it would be easy to weary you with it, but I trust you will bear with me while I touch upon one or two points farther. As we understand the matter, there is opposition on the part of the manufacturers of steel to having the consumer put out chemical specifications in detail. It is claimed that the consumer should only specify the physical properties of the metal, and exclude or limit by the chemistry only constituents which are objectionable, leaving the steel maker free to vary those constituents upon which the most valuable properties of the metal depend, according to his own ideas. This feeling, if we are rightly informed, is much stronger abroad than it is with us, and we have been told that steel makers abroad would not bid on a specification of which complete chemical requirements were a part. From what has preceded it will not be difficult to understand how we feel about this matter, and it is hard for us to conceive where the method outlined above is followed, and especially where the manufacturer has a chance to criticise a specification before it is issued, why there should be any reasonable ground for antagonism to complete chemical specifications. The position which we hold in the matter is that a certain set of physical properties produced by, for example, high carbon and low manganese, may give a steel more valuable to the consumer than approximately the same physical properties produced by lower carbon and higher manganese, or other interchange of the constituents commonly affecting the physical properties of steel. Moreover we cannot help feeling that the chance to study the behavior of metal in service and the relations between its chemical composition and that behavior is a source of information which should not be ignored. No one can deny that this chance is more open to the consumer than to the producer, and we fail to see why the producer should shut himself out from this source of knowledge.

Another point will perhaps bear a few words. We have found it difficult in our work to make any definite rule universally applicable as to how such material should be represented by one sample. Where materials are made in batches or in heats and the sample is selected at random no serious difficulty has thus far arisen in making one sample represent a heat or batch. Where a shipment as in the manufacture of alloys, may be made up of material resulting from a number of like operations without any certainty as to uniformity in the output of each complete operation, the question of sampling is more difficult. The same may be said of oils and paints and other related materials. In such cases it is usually customary with us to make an arbitrary sampling and to follow this sampling by occasional more complete sampling after the material has been received and passed upon. If such more complete sampling shows lack of uniformity in the shipment of material involved it may not infrequently lead to a modification of the specification.

Closely related to the question of the amount represented by one sample is how many individual parts shall make up the average sample. For example, shall one ingot represent 20,000 lbs of an alloy, or shall more than one? In a shipment of oil shall a sample from one barrel be used, or shall smaller samples from each barrel be mixed to form one average sample. Our practice has been to limit the number of sub-samples entering into the average sample as much as possible, on the ground that the material should be uniform, and that the specification provides wide enough limits to make up for the ordinary variations, where the manufacturing or shop practices are reasonably good. If the material is uniform, or all of it within the limits of the specification, the multiplication of sub-samples really serves no useful purpose, and as we really buy and pay for a material described by the specification it is not unfair to expect that any and every part of it should be in accordance with that specification.

Another closely related point is the question of retests. A shipment of material has been received, sampled in the regular way and tested, and the material does not stand test. It not infrequently happens that the producer asks for another test, with the hope and expectation that this test will show that the material meets the requirements. No small amount of correspondence and personal interviews have been expended over this matter. Our general position upon this subject has been to decline retests, the theory being that the specification was not drawn for the purpose of making it easy for irregular, and we may say possibly carelessly made, material to be accepted. If a second test is made which does meet requirements it is obvious that the consumer would naturally want to make a third test, and see which one the third test sustained, and we believe many specifications are drawn with such provisions. We cannot but think that this is bad practice, and that it is infinitely better to make the limits of the specification wide enough when they are first drawn, so that they will cover all the uncertainties in manufacture, except carelessness, bad judgment, or an attempt to sell an inferior product at the price of a good one. It is very gratifying to be able to state that with the large number of specifications enforced on the Pennsylvania Railroad where each shipment is now examined and has been for quite a period of time, the number of rejected shipments which fail to meet the specifications varies from 1.50 to 2.50%; possibly sometimes a little higher. Usually the rejections are characteristic of the new specifications, that is to say, when a specification has been out long enough so that manufacturers have had a chance to adapt themselves to its requirements it is very rare that we have rejections.

Another point may be worth a few words, namely, is it possible to so draw a specification that material which has once been rejected will not be offered a second time. There is perhaps no point connected with the specifications which is more difficult to handle than this one. It is recognized that the putting of marks on rejected shipments, as is the custom in government work, deteriorates the quality of the product, and of course adds a good deal to the cost, since the manufacturer must requite himself for the material so condemned. When materials bear serial numbers placed upon them for his own purpose by the manufacturer, the problem is less difficult, but for the mass of products which are made the subjects of specifications, such identifying marks are not available. It is perhaps fair to say that we have had shipments of rejected material returned to us, and have a second time rejected them on the second sample. Our feeling is that where there is a clause in the specifications that the manufacturer must pay return freight, very few reputable people at least, will run the risk of a second rejection, by returning material which was once condemned. Moreover it is very difficult to so mark rejected material with a private obscure identification mark, that it can be recognized if it is returned, and as has been stated by the purchasing agent, it is easy to meet such cases, where the matter is free from doubt by withholding orders from those who indulge in such practice. Our experience has been that the commercial world desires rather to do a straightforward, open, honest business, in a straightforward, honest way, and that where the specifications are reasonable, and the processes fair, there will be very little difficulty on this score.

Two points more and I am finished: First, how do specifications affect the business of producers, and second, what is the effect of specifications on the prices of materials. Upon the first of these points let us say, we are well aware that many producers object to specifications on the ground that they are annoying and harassing, and really serve no good purpose. On the other hand we are able to say that some manufacturers have asked that specifications be prepared, and one large producer indeed told us in conversation, that the more difficult the specification the better they like it, on the ground that it limited the competition which they would have in producing the product. There is a point here which is perhaps worth a few words. Let us suppose that an honest manufacturer is making a good product. He understands his business, and has good facilities, and is turning out an excellent article. When he comes to sales, he is called upon to meet in competition, let us assume, those who are not equally well equipped, and who in order to secure a market must offer lower prices. In order to recoup for this diminution in price, he, of course, must make an inferior product. So long, therefore, as the consumer buys on price alone and without any specification or examination of shipments, the honest, competent manufacturer is at a disadvantage. On the other hand, if there is a good, workable specification in force and each shipment is examined, the unfair competition of the inferior manufacturer is entirely eliminated. We have many times stated in conversation with manufacturers, that in our judgment those who are doing a legitimate, straightforward, honest business, should be the strongest friends that specifications have, and it is gratifying to be able to state that many manufacturers of commercial products look at the matter in this light.

Finally, in regard to the effect of specifications on prices: Many consumers fear that if they enforce specifications, the price of the product will seriously increase. This seems a legitimate fear, and it is a fair question if the facts are as they seem to be, whether the value of the material according to the specifications, is equal to the increased cost. It is gratifying to be able to state that experience indicate that after a specification has passed what may be called the "experimental state," and is working smoothly, prices show a strong tendency to drop below the figures prevailing at the time the specification was issued. This seems to be due to two or three causes: First, the manufacturers are all competing on the same quality of product, hence genuine competition prevails. Second, the specification describing what may be called a "stable commodity," for which there is a set demand, slack time at the works may be employed in making this product in advance of orders, thus employing facilities to the best advantage. Third, the constituents entering into a specification material for which there is a steady demand can, without fear of loss, be purchased in large lots, and at the best stage of the market, thus securing the lowest prices. Whatever the causes, the effects on not a few materials are as stated. Of course, supply and demand are important elements in prices, and there will undoubtedly be fluctuation, but it will not be difficult to give instances in which this general tendency of specifications is clearly seen.

In order that what has preceded may be put into fairly concrete form, I beg to submit the following conclusions, as in a sense summing up what has already been said:

(1) A specification for material should contain the fewest possible restrictions, consistent with obtaining the material desired.

(2) The service which the material is to perform, in connection with reasonably feasible possibilities in its manufacture, should determine the limitations of a specification.

(3) All parties whose interests are affected by a specification should have a voice in its preparation.

(4) The one who finally puts the wording of the specification into shape, should avoid making it a place to show how much he knows, as well as, a mental attitude of favor or antagonism to any of the parties affected by it.

(5) Excessively severe limitations in a specification are suicidal. They lead to constant demands for concessions, which must be made if work is to be kept going, or to more or less successful efforts at evasion. Better a few moderate requirements rigidly enforced, then a mass of excessive limitations, which are difficult of enforcement, and which lead to constant friction and sometimes to deception.

(6) There is no real reason why a specification should not contain limitations derived from any source of knowledge. If the limitations shown by physical test are sufficient to define the necessary qualities of the material, and this test is simplest and easiest made, the specification may reasonably be confined to this. If a chemical analysis or a microscopic examination, or a statement of the method of manufacture, or information from all four, or even other sources, are found useful or valuable in defining limitations, or in deciding upon the quality of material furnished, there is no legitimate reason why such information should not appear in the specifications. Neither the producer nor the consumer has a right to arrogate to himself the exclusive right to use information from any source.

(7) Proprietary articles and commercial products made by processes under the control of the manufacturer cannot, from the nature of the case, be made the subject of specifications. The very idea of a specification involves the existence of a mass of common knowledge in regard to any material, which knowledge is more or less available to both producer and consumer. If the manufacturer or producer has opportunities, which are not available to the consumer, of knowing how the variation of certain constituents in his product will affect that product during manufacture, so also does the consumer, if he is philosophic and is a student, have opportunities not available to the producer, of knowing how the same variation of constituents in the product will affect that product in service, and it is only by the two working together, and combining the special knowledge which each has, that a really valuable specification can be made.

(8) A complete workable specification should contain the information needed by all those who must necessarily use it, in obtaining the material desired. On railroads this may involve the purchasing agent, the manufacturer, the inspector, the engineer of tests, the chemist, and those who use the material. A general specification may be limited to describing the properties of the material, the method of sampling, the amount covered by one sample, and such descriptions of the tests as will prevent doubt or ambiguity.

(9) Where methods of testing or analysis or inspection

are well known and understood it is sufficient if the specification simply refers to them. Where new or unusual tests are required, or where different well-known methods give different results, it is essential to embody in the specification, sufficient description to prevent doubt or ambiguity.

(10) The sample for test representing a shipment of material should always be taken at random by a representative of the consumer.

(11) The amount of material represented by one sample can best be decided by the nature of the material, its importance, and its probable uniformity, as affected by its method of manufacture. No universal rule can be given.

(12) The purchaser has a right to assume that every bit of the material making up a shipment, meets the requirements of the specification, since that is what he contracted for and expects to pay for. It should make very little difference therefore, what part of the shipment the sample comes from, or how it is taken. Average samples, made up of a number of sub-samples, are only excusable when the limits of the specification are so narrow that they do not cover the ordinary irregularities of good practice in manufacture.

(13) Retests of material that has once failed should only be asked for under extraordinary conditions, and should be granted even more rarely than they are asked for, errors in the tests of course excepted.

(14) Simple fairness requires that when it is desired that material once fairly rejected should nevertheless be used, some concession in price should be made.

(15) Where commercial transactions are between honorable people, there is no real necessity for marking rejected material, to prevent its being offered a second time. If it has failed once, it will probably fail a second time, and if return freight is rigidly collected on returned shipments the risk of loss is greater than most shippers will care to incur. Moreover, it is so easy for the consumer to put an inconspicuous private mark on rejected material, that it is believed few will care to incur the probable loss of business that will result from the detection of an effort to dispose of a rejected shipment by offering it a second time.

(16) All specifications in actual practical daily use need revision from time to time, as new information is obtained, due to progress in knowledge, changes in methods of manufacture, and changes in the use of materials. A new specification, that is one for a material which has hitherto been bought on the reputation of the makers and without any examination as to quality, will be fortunate if it does not require revision in from six to ten months, after it is first issued.

(17) In the enforcement of specifications, it is undoubtedly a breach of contract legitimately leading to a rejection, if the specified tests give results not wholly within the limits, and this is especially true if the limits are reasonable wide. But it must be remembered that no tests give the absolute truth, and where the results are near, but just outside of the limit, the material may actually be all right. It seems to us better, therefore, to allow a small margin from the actual published limit, equal to the probable limit of error in the method of testing employed, and allow for this margin in the original limits, when the specifications are drawn.

(18) Many producers object to specifications on the ground that they are annoying and harassing, and really serve no good purpose. It is to be feared that the complaint is just, in the cases of many unwisely drawn specifications. But it should be remembered that a good reasonable specification, carefully worked out, as the result of the combined effort of both producer and consumer, and which is rigidly enforced, is the best possible protection which the honest manufacturer can have against unfair competition.

(19) Many consumers fear the effect of specifications on prices. Experience seems to indicate that after a specification has passed what may be called the experimental stage, and is working smoothly, prices show a strong tendency to drop below figures prevailing before the specification was issued.

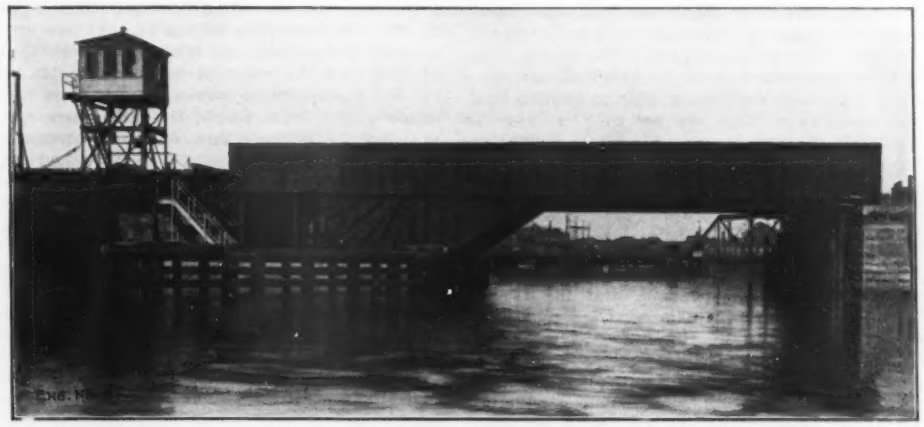
(20) A complete workable specification for material represents a very high order of work. It should combine within itself the harmonized antagonistic interests of both the producer and the consumer, it should have the fewest possible requirements consistent with securing satisfactory material, should be so comprehensive as to leave no chance for ambiguity or doubt, and above all should embody within itself the results of the latest and best studies of the properties of the material which it covers.

HEAVY PLATE-GIRDER ROLLING LIFT BRIDGE AT BRIDGEPORT, CONN., N. Y., N. H. & H. R. R.

We illustrate herewith a heavy plate girder rolling lift bridge recently completed over the Pequonnock River, at Bridgeport, Conn., on the line of the New York, New Haven & Hartford R. R., to replace a double-track swing bridge.

The new bridge is composed of two double-track plate girder spans, placed side by side, to be operated jointly or separately as desired. The Pequonnock River is quite wide at this crossing and the movable part of the bridge is reached by several fixed plate girder approach spans, extended from each shore. The new bridge provides a waterway for navigation 80 ft. wide in the middle of the river. Sufficient headroom is provided for the passage of tugs and small craft without moving the bridge. These features, together with the rapid operation of the bridge, will reduce delays to railroad traffic, from the passing of vessels, to a minimum.

Powerful electric motors are provided so as to move the bridge very rapidly. A 50-HP. motor is provided for each double-track bridge. The operation of the entire bridge is controlled by a single operator, stationed in the operator's house. This house is elevated sufficiently high to give a



SCHERZER ROLLING LIFT BRIDGE OVER THE PEQUONNOCK RIVER, BRIDGEPORT, CONN., FOR THE NEW YORK, NEW HAVEN & HARTFORD R. R. CO.

commanding view of the river and the railroad tracks.

The bridge is counterbalanced by cast-iron blocks attached to the short arm and plainly seen in the view. The entire weight of the structure is carried by two large rockers which roll on plate girder tracks supported on continuous masonry piers.

The building of the new movable bridge forms a continuation of the permanent improvements in progress for several years at Bridgeport, by the New York, New Haven & Hartford Co., under the direction of Mr. F. S. Curtis, Fourth Vice-President, and Mr. C. M. Ingersoll, Jr., Chief Engineer. The plans of the entire substructure and the approach spans were prepared by the engineers of the New Haven & Hartford Railroad Company, Mr. W. H. Moore, Bridge Engineer; the local Engineer in Charge being Mr. R. M. Berriam.

The Pennsylvania Steel Co. were the contractors for the superstructure. The Scherzer Rolling Lift Bridge Co., of Chicago, furnished the designs, plans and specifications of the superstructure, operating machinery and operating equipment and maintained a consulting engineering supervision over the construction. We are indebted to the Scherzer Co. for the information from which this article has been prepared.

ANNUAL CONVENTION OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

Over five hundred members, guests, and ladies met at Niagara Falls on the occasion of the 20th annual summer convention of the American Institute of Electrical Engineers, held during the week of June 29 to July 3. On five mornings of that week the Institute (but not the five hundred) met for professional discussion in the auditorium of the Natural Food Co., and on the afternoon they journeyed out to the power plants and factories in the neighborhood to see how electricity is practically used. An energetic local committee had made preparations which converted the week into one round of activity. However, the work of the meeting encroached upon the entertainment, in that an interpolated session became necessary in order to handle all of the mass of papers presented.

Of the industrial city of Niagara Falls revealed to the visitors by the various excursions, we need say nothing here,* except to mention that among the new developments shown is the Otto ozone water purification process, which is in some use abroad and is to be introduced into this country by the Atmospheric Products Co. The new feature of the method is the means used for producing ozone by brush discharges at high potential; the quantity of electrical power required is relatively small. The work of constructing the water-power plants on the Canadian side of the falls is being pushed with vigor. One plant is to be closely similar to the plant of the Niagara Falls Power Co. on the American side, using a great wheel-pit in which the turbines are placed and whence the water is led to the lower reach by a tail-race tunnel.† The excavation of the wheel pit is practically completed, and the tunnel has been put through and is being lined. Some of the head-works masonry is already set, and part of the hydraulic machinery (in units of 10,000 HP., built by Escher, Wyss & Co., Zurich, Switzerland,) is on the ground. Two other plants are to be built farther up on the Canadian side; three great wing-dams thrown a thousand feet out into the river have laid dry a large piece of river-bed, on which construction work is now progressing. One of the plants is to use the wheel-pit construction, leading away the tail water by a tunnel under the river-bed, to Horseshoe Falls, while the other will lead the headwater by canal and pipe to a power house situated below the falls. The work in progress is of much interest, and we hope to be able to present some description of it in a coming issue. The visiting Institute also inspected substations of the Buffalo Railway Co., of the Buffalo General Electric Co., and of the Niagara Falls Power Co., the Buffalo terminal station of the transmission line from Niagara and the central exchange of the Bell Telephone Co. at Buffalo.

A dance, a musical entertainment, a demonstration of the Hewitt mercury-vapor lamp, the vapor converter, and the vapor circuit-breaker, and an exhibition of a new form of reverse-current circuit breaker, filled out the remainder of the time. An especially interesting matter was the announcement and demonstration of the Hewitt single-phase vapor converter, transforming alternating into direct current. To make this possible the alternating current is split up into two opposite phases and these passed through the vapor converter shunted by a choke-coil which produces sufficient lag on one phase to always keep the pressure above zero, so that the converting operation is uninterrupted.

GENERAL PROCEEDINGS.

The meeting was opened at 10.30 a. m., Monday, June 29, by an appropriate welcoming speech of Mayor Hancock, of the city of Niagara Falls.

After a brief acknowledgment of the welcome, President C. F. Scott (Pittsburg, Pa.) presented his address, an abstract of which was printed in our issue of July 2.

A report of the committee on Branch Organiza-

*See our report of the meeting of the American Electrochemical Society last fall, Eng. News, Sept. 25, 1902.

†See a short description by Mr. H. W. Buck, Eng. News, July 3, 1902.

tion was presented by its chairman, Mr. C. W. Rice (Pittsburg, Pa.). Great progress and successful activity was reported, and a look into the future made in the following words:

> One need not fear that the movement will promote separate engineering societies in the different cities who will divorce themselves from the central organization.

Some discussion on the report brought out the fact that the branches are highly thought of by the teachers of electrical engineering. At Purdue, where an electrical society has existed among the students, this society gave up its organization and formed itself the local branch of the Institute, under the presidency of Prof. W. E. Goldsborough. At Cornell, on the contrary, the existing electrical club was intentionally kept distinct from the branch movement, so as to furnish a center for independent discussion, while the Institute branch constitutes a part of the work in design regularly carried on by upper-class students; the papers of the Institute are studied, as required work, but there is no independent discussion thereon, and, as Prof. H. J. Ryan says, there can not well be any. As explaining the status of the student affiliation, Secretary Pope stated that it is a "student enrollment" but not a grade of membership; the "Transactions" are furnished to these students at a reduced price.

Among other business of a general nature was the resolution to hold an electrical congress at the Louisiana Purchase exposition, and the resolution to recommend that this congress adopt the new saturated-solution cadmium or Weston cell as a standard source of electromotive force. This cell was discussed in a paper by Prof. H. S. Carhart (Ann Arbor, Mich.), who is now conducting very careful experiments to determine its exact voltage. Prof. A. E. Kennelly (Cambridge, Mass.) read a paper urging the consideration of magnetic and electric units, with the object of bringing them closer to an absolute system. The words absampere and abvolt were suggested to designate units of current and voltage in an absolute system. These two papers were ordered printed in pamphlet form and distributed among American and European scientists in order to prepare for action upon them at the electrical congress.

PROFESSIONAL PAPERS.

First of the professional papers was one by Prof. W. S. Franklin (South Bethlehem, Pa.,) on "Energy Transformations in the Synchronous Converter." As is well known, the synchronous converter, usually called rotary converter to distinguish it from the stationary alternating-current transformer, is a closed-coil direct-current dynamo which has, in addition to the commutator and brushes, a set of slip-rings connected to certain points of the winding. Alternating current supplied to the slip-rings causes the armature to rotate and supply direct current at the brushes, or vice versa. In considering this machine, the current actually flowing in the armature is thought of as made up of two parts, a direct current and an alternating current superposed. The author points out that the current flowing in the armature is a single current, and in certain problems must be considered as such. He compares the armature winding of the converter to the winding of an auto-transformer, and bases on this comparison a mathematical analysis of the energy-interchanges between different parts of the armature. He calculates that in two-ring converters 59% of the current is transferred from the slip-rings to the brushes by direct conduction, in the three-ring converter 76%, in the four-ring converter 87%, and in the converter with an infinite number of rings 88½%; the remainder in each case is transferred by motor-dynamo action between different coils. In discussion, Prof. S. Sheldon (Brooklyn, N. Y.) suggested that graphical plotting of time-current curves would lead to the same results much more simply, and that the graphical method could be applied to any wave-form of current while the other assumes a sinuoidal wave.

A paper on "Commercial Alternator Design" was read by Mr. W. L. Waters (Milwaukee, Wis.). The author would lay special stress in designing on abundant provision for ventilation of armature and field, so as to secure a maximum temperature-rise of 30° C.; voltage regulation on low power-factors is a second feature much neglected and yet very important. Mr. R. D. Mershon (New York, N. Y.) claimed that 30° C. was too low a limit for heating, since the purchaser would have to pay an extra price; 40° to 45° has been found a satisfactory limit in commercial work. Mr. Waters stated, however, that his company is using the 30° specification in building machines for the open market, and was satisfied with it. Old-established companies find it easier to sell machinery on inferior guarantees. The inductor alternator, which Mr. Waters attacked as uneconomical and poor in regulation, was defended by Mr. D. B. Rushmore (Pittsfield, Mass.) on its record in California transmission work.

ELECTRIC RAILWAYS.

Under the title "High-Speed Electric Railway Problems," Mr. A. H. Armstrong (Schenectady, N. Y.), discussed the effects of schedule speeds, number of stops, etc., on the current consumption of cars and the required motor capacity, using car and train-friction curves deduced from experiments by Mr. W. J. Davis, Jr., three years ago, on the Buffalo-Lockport line of the International Railway Co. An example is then worked out as to the comparative cost of one-car and two-car operation on a line 100-miles long, schedule speed 40 miles per hour, stops every four miles, half-hour service for single cars and hour service for two-car trains. It is found that the two-car system, with its higher power capacity required in the substations (but less in the generating station), would cost $1,090 more per mile of line, first cost. But the saving in current would be $116.50 per year (at 0.7 cts. per KW.-hr.), which capitalized at 10% is $1,165. The obvious conclusion is:

> It would, therefore, pay to invest the $1,090 per mile of track difference in cost between one and two-car operation, provided the same receipts could be secured with one hour headway as with 30-minute headway.

The paper was not discussed.

Mr. F. L. Sessions read a paper on "Storage Battery Industrial Locomotives," in which he discussed the principal requirements in such machines, the ways they may be arranged relative to the supply, and the control arrangements. The calculation of the battery equipment is facilitated by a number of tables which are given in the paper and whose use is illustrated by examples. In discussion, the feasibility of charging the batteries from a trolley-wire was questioned, and the use of resistances for control was condemned because of the waste energy involved. The reply was that the charging by trolley is perfectly feasible and control resistances have proved quite successful, as they are small and the loss therefore negligible. The point was made that compressed air locomotives are useful, in spite of their low efficiency, because of their convenience, which argument holds equally for battery locomotives.

An analytical discussion of the determination of speeds, distances, etc., in preliminary calculations for electric railways was given by Mr. F. W. Carter in a paper on "Predetermination in Railway Work." The essential novelty is the assumption that a rectangular hyperbola represents the relation between speed and current during the time of "free running" of the car; i. e., after acceleration and before current is shut off or brakes applied. The acceleration, "free running," and braking portions of the speed-time curve are treated separately to give the total energy consumption for any given speed-condition. The paper covers analytically a similar field as was covered graphically by Mr. C. O. Mailloux in a paper on "Speed-Time Curves," read before the convention of a year ago.

A record of a very elaborate series of tests on interurban car operation on long runs was presented in a paper entitled "Interurban Car Tests," by Prof. W. E. Goldsborough (Lafayette, Ind.) and Mr. P. E. Fansler (St. Louis, Mo.). The line on which the tests were run was that of the Union Traction Co. between Marion and Indianapolis, Ind.,* where both local and through cars operate. The tests were entirely electrical, the current, voltage and power being measured at very brief intervals. The variations in energy consumption are discussed, with the general conclusion that a large personal element enters into the handling of a car. By individual motor tests the differences between cars were also studied. The whole work was largely done by students of Purdue University.

Prof. S. Sheldon (Brooklyn, N. Y.) and Mr. J. D. Kelley (Brooklyn, N. Y.) presented a paper on "Some Recommendations Concerning Electrical and Mechanical Specifications of Trolley Line Insulators." In order to furnish data for comparison and rating of different insulators they were tested for those qualities which are required of them in service. These qualities are (1) Mechanical strength. (2) Dielectric strength, i. e., breakdown voltage, (3) Plasticity, or resistance to heating, and (4) Insulation resistance. On the basis of the tests made for these qualities on a large number of different insulators some specification clauses are recommended.

Mr. J. Sachs (Hartford, Conn.) suggested that the effect of vibration on the mechanical strength should be tested for, as it occurs in use. The mechanical strength of an insulator of given size may be increased by allowing a lower insulation resistance. This latter is the important thing rather than breakdown voltage, as the leakage of current depends on the insulation resistance, and with the many insulators on a line small leakage at each becomes important. Moreover, leakage produces heating, and no insulator is made that will stand any considerable heating. Of course the size and cost of the insulator must be balanced against the leakage. There was some discussion on the effect of dielectric hysteresis in producing heating during the insulation test (which was made with alternating-current), but Professor Sheldon stated that the duration of each test was so short that no appreciable heating could have been produced. With longer duration of test, Mr. R. D. Mershon (New York) stated that earlier failure is produced by alternating than by direct current, according to some recent tests made by him.

Prof. W. E. Goldsborough (Lafayette, Ind.) and Mr. P. E. Fansler (St. Louis, Mo.) had a second paper, which dealt with parts of the series of tests on the Union Traction Co.'s system in Indiana that was treated in part in this paper on Interurban Car Tests. This second paper, entitled "The Storage Battery in Substations," described the battery equipment at the substations and gave the voltage and current curves of batteries, rotary converters, and outgoing line, as determined from extended tests. The curves are interpreted in connection with the car schedule on the line, which is such as to produce 3-hour cycles of charge and discharge of the batteries. The value of the batteries as equalizers is discussed. Some tests are also given on the efficiency of the rotaries with which the batteries work in parallel. It was suggested by Mr. H. G. Stott (New York) that valuable information would be obtained by finding the operating efficiency with the batteries cut out for one week, and then with the batteries in use; but Prof. Goldsborough said that this was impossible on the line in question.

Mr. C. Renshaw (Pittsburg, Pa.) discussed the heating of railway motors in a paper "Some Notes on the Operation of Railway Motors in Service." The main feature of this paper is a set of interval temperature curves of railway motors in actual all-day service. The tests were made on cars of the Pittsburg Railway Co., on runs about 18 hours continuous service.

One of the cars tested took on a trailer for one round trip in the morning and one in the evening, during the rush hours, and on these trips the average passenger load was 50 to 100% greater than on other trips. While it would hardly be thought that the trailer affects the motor heating, it is shown by the curve that a very sharp rise from 80° C., the steady running temperature, to nearly 100° C. is produced by the evening trailer, while the morning trailer raises the steady maximum temperature of the motor from 70° C. to 80° C., the former figure being given by a car which is run without trailer all day. This clearly points out that near the heating limit of the motor the latter is extremely sensitive to additional de-

*For a description of the line and equipment see an article in Eng. News, Nov. 13, 1902.

mands, such as the addition of a trailer for a single trip in the morning and evening. The paper was discussed by Mr. C. T. Hutchinson (New York), who outlined a graphical method which he had devised to obtain the limiting current values for a motor of given size on a given kind of run, from several sheets of average curves derived from actual tests.

HIGH-TENSION TRANSMISSION.

High-tension work was the special subject for Wednesday, July 1. A Committee on High-Tension Work has been in existence for some time, and to aid this committee in formulating a code of safe or preferred practice certain of the matters in which practice differs were brought up for discussion at this time. Eight papers by different authors were presented to introduce the open discussion. These were read and separately discussed, as follows:

Mr. C. E. Skinner (Pittsburg, Pa.), in a paper entitled "Methods of Bringing High-Tension Conductors into Buildings" described two ways in which high-tension line wires may be passed through walls; the wire must be kept thoroughly insulated from the wall, cold and rain must be kept out of the building, and precautions must be taken against accumulation of dirt and moisture around the wire, as this would lower the insulation, producing leakage of current and possible arcing across. Mr. H. Floy (New York), in a letter, described his preferred method. A small hanging shed is extended out from the building, the line wire brought up through a hole in the floor, turned at right angles, and carried through a hole in the wall of the building. The two holes being at right angles, the cold is kept out quite effectively. The glass plates and tubes of Mr. Skinner's sketches are objectionable on account of breakage, leakage of current, etc., and the simple hole in the wall is the best insulation. The lightning arresters may be placed in the shed extension referred to. Mr. O. H. Ensign (by letter) prefers to avoid any enclosed space as that between two glass plates. The objection that dirt, moisture, birds' nests, etc., would accumulate in an open-ended pipe as shown was urged by several. One of the arrangements shown by Mr. Skinner (using a glass tube around the wire) has been used at Snoqualmie Falls from the first and has given no trouble. Trouble by breaking of the tubes has been overcome by careful selection, but porcelain tubes were suggested as preferable. At Ogden, Utah, the 40,000-volt transmission wires are passed, 6 ft. apart, through 2-ft. square holes in the corrugated iron wall; but often arcs jump across there, which in some cases is certainly due to lightning, while in other cases it is not known whether line-current or lightning is the cause. The method now being introduced for exclusive use in Utah is to have an inner and an outer glass plate, 2 to 3 ft. square, as necessary, with a 2½ in. hole drilled in the center of each; a glass or better, a porcelain tube of requisite thickness is slipped over the wire and passed through the holes in the glass plates. Better rain protection than that shown by Mr. Skinner was called for by Mr. P. H. Thomas (Pittsburg, Pa.) and Mr. V. G. Converse, the short overhanging eave shown by Mr. Skinner being considered insufficient.

Mr. R. D. Mershon (New York) in a paper "The Grounded Wire as a Protection Against Lightning," made an estimate calculation of the shielding of the line wire due to a grounded wire near by, against the high potentials due to electrostatic induction from charged clouds. Barbed wire is often used for the grounded wires. The discussion of this paper, by Messrs. R. S. Kelsch, F. A. C. Perrine, C. O. Mailloux, A. J. Wurts, P. H. Thomas, A. E. Kennelly, P. M. Lincoln and others, showed a difference of opinion as to the value of grounded wires as a protection against discharges. It was generally agreed that they were no protection against lightning, but some held that excessive strains due to atmospheric charges might be avoided by this means, while others considered that this protection was open to doubt, and that the added complication of the grounded wires made them undesirable. Barbed wire found few supporters. Mr. Perrine, while he thought a proper kind of barbed wire might be of value, held that it is unwise to fool with barbed wire of the ordinary kind. The suggestion was made to unite in collecting evidence systematically as to line discharger used on some Italian transmission lines in this way our at present imperfect knowledge concerning such phenomena might be much increased in a short space of time. A water-drop discharger used on some Italian transmission lines was described, the water from a tank dropping on the line-wire near the terminal station acting as an efficient substitute for lightning arresters.

It is usual to test completed electrical machinery for insulation strength by subjecting the whole machine to an excess voltage, applied for a longer or shorter period of time. Certain objections to this procedure were discussed by Mr. P. H. Thomas (Pittsburg, Pa.) in a paper on "The Testing of Electrical Apparatus for Dielectric Strength." The machine should be thoroughly dry in all its parts when such a test is undertaken, which is not always the case. In any case the heating of the insulation during the test may easily injure the insulation and make it less able to withstand high voltage strains subsequently. In discussing the paper several members upheld the objections advanced by the author. It was suggested that breakdown tests on samples would suffice to indicate the dielectric strength of the machine, and would avoid risk of weakening the machine locally which is always present when high test voltages are applied. It was answered, however, that the strength of the insulation in samples is not greatly in question, but that it is necessary to know whether the insulation at any point has been cracked or weakened in building the machine. For this purpose, excess voltage for testing are a necessity, but they should be maintained only a very short time, while the tests for insulation resistance may be carried out at lower voltage and may extend over a longer time. For the puncture tests a voltage of double the normal, applied for one minute, was said to be not too high. The distortion of the potential wave-form by some testing apparatus was mentioned, as applying a higher maximum potential strain to the insulation than is measured.

Only two frequencies of alternating current are used in this country widely enough to be called standard: 25 to 60 cycles per second. Various factors determine the selection of the frequency on any given system, one of them being the effect of frequency on the carrying capacity of the transmission line. This factor was separately considered in a paper on "Choice of Frequency for Very Long Lines," by Mr. P. M. Lincoln (Pittsburg, Pa.). Neither of the two standard frequencies introduces much danger of high voltage strains from resonance effects, on lines of the maximum length yet contemplated. But the voltage regulation of the line and the "charging current" required are serious points to be considered in selecting the frequency. With equal inductance drop (20% assumed) on the line, the limit of power which can be transmitted over a 200-mile line is much higher for 25-cycle than for 60-cycle current; the figures given by the author are 500 KW. for 60-cycle and 1,250 KW. for 25-cycle current, when the voltage at the receiving end is 20,000, while with a receiving voltage of 60,000 the limit of power is 4,500 KW. for 60-cycle and 11,250 KW. for 25-cycle current. The charging or capacity current is also very much greater with the higher frequency, producing less economical operation. The discussion of this paper turned mainly on the fact that in the ultimate choice of the frequency to be adopted on a system the line is not the only element to be considered; in fact, besides the generating and transforming machinery, etc., there are commercial matters to be considered, and such as the demand for higher frequency on the part of the consumer, the need of high frequency for lighting. There was some difference of opinion as to the minimum frequency permissible for lighting purposes without producing flickering of the lamps. Mr. H. G. Stott (New York) thought that about 20 cycles is the minimum, while the entire system of the Manhattan Railway (elevated) is now lighted on 25 cycles without any trouble; however, low voltage and low-efficiency lamps are used here, which tends to reduce any flickering. Mr. R. D. Mershon (New York) also held 25 cycles permissible for lighting in most cases. Others, however, thought that the minimum lay between 30 and 50 cycles per second.

"Star or Delta Connection of Transformers," by Mr. F. O. Blackwell, presented various arguments for or against one or the other method of connecting transformers on a three-phase system. In transformers of small capacity, Y-connections of the high-tension side gives economy in cost and weight. Larger transformers are often better connected in delta, at least on one side. Sudden potential rises may occur with star-connection under certain conditions, at least when the neutral is grounded as appears desirable for certain reasons. Moreover, one side of the delta may be cut out for substitution without interrupting the service. Other arguments on both sides are also given in the paper, with the conclusions following:

> In small installations the cheaper cost of transformers for star connection with a grounded neutral will be a determining factor. Larger plants will be guided by the greater importance of giving uninterrupted service and will not employ a grounded neutral unless demanded on the score of safety. Where the amount of power is great and the system extensive, delta connection will be generally preferred on account of its avoiding the possibility of rises of potential from any cause. Many plants can have advantageously a mixed system with both star and delta transformers, each installation of transformers being considered by itself.

An auxiliary paper by Mr. J. S. Peck (Pittsburg, Pa.) on "Grounded and Underground Transmission Circuits" discussed a number of abnormal conditions of strain on the insulation, with various kinds of connection. For instance, it was shown that with a set of transformers whose primaries are star-connected with grounded neutral, and whose secondaries are delta-connected, if one side of the delta be open and one of the primaries short-circuited a potential strain of three times the normal may occur between the two sides of the delta. Messrs. Hayward, Gerry, P. N. Nunn, P. H. Thomas, P. M. Lincoln and P. Junkersfeld, discussed the paper. Some of the western high-tension transmission plants operate with grounded neutral, while others do not. With proper operation it was thought that good results can be obtained with either delta or star connection. On the Chicago Edison system the generators have been worked very successfully the past three or four years with grounded-neutral star connection, using a 4-wire 3-phase distribution. An essential point in the successful operation of the system is the abolition of single-pole fuses and switches; only three-pole oil switches are now being installed there.

In a paper on "Electric Cables for High-Voltage Service" Mr. H. W. Fisher mentioned briefly some essential points in the manufacture, installation and use of cables. No preference was expressed for either rubber or paper-insulated cables, but it appears that both can be made for high voltages (up to 20,000) at about equal cost for equal initial strength; at ordinary voltages the paper cable is much the cheaper. The operation of cables in multiple ducts calls for attention to the heating of the innermost cables of a set; a temperature approaching 90° C. is dangerous at any time. The statement was made that the carrying capacity of cables as frequently recommended is too great when many cables are in the same duct-system. Mr. P. Torchio (New York) presented a somewhat related paper on "The Operation and Maintenance of High-Tension Underground Systems." The paper recommended, among other things, periodic tests, say weekly, of the insulation resistance of high-tension feeders, and counseled that tests of dielectric strength be applied very carefully or even avoided entirely. In a paper on "Automatic Means for Disconnecting Disabled Apparatus" Mr. H. G. Stott (New York) argued for the use of reverse-current circuit-breakers on all generators, these acting to cut out any generator when current flows into it instead of out, and an independent operation of feeders to substations, together with multiple operation of the outgoing direct-current lines. This latter plan is used on the cable-distribution of the Chicago Edison Co., as the discussion showed. The cables here were changed from 4,500 volts to 9,000 volts some time ago, and only a few burnouts have appeared, some of which could have been detected by previous high-tension tests. Similar experiences in New York were reported in Mr. Torchio's paper. The cable distribution system of the Manhattan Rail-

way (New York) comprises 120 miles of cable operating at 11,000 volts, and only one fault has been found, while only four breakdowns have occurred. A source of trouble has been the current flowing in the lead cable-sheath, which could not be rendered harmless by any practicable amount of copper reinforcement of the sheath. These currents are return currents from the street railway, and in the future all cables will rest on insulated hangers, with a ground on the sheath at the power house. The current flowing in the sheath produces more heating than the current in the cable itself. As to the heating of cables in multiple ducts, Mr. Fisher stated during the discussion that the minimum temperature in a 2-cable duct was 74%, in a 4-cable duct 85% of the temperature in the center of an 8-cable duct.

OTHER PAPERS.

At the session of Thursday, July 2, a number of papers on miscellaneous subjects came before the meeting, as follows: Messrs. J. W. Esterline and C. E. Reid (Lafayette, Ind.) read a paper on "The Factors Which Affect the Energy Losses in Armature Cores," which reports the results of a large series of tests on both smooth and toothed armature cores, with either solid or laminated field poles. The curves of losses plotted from the results show clearly the greater loss due to extra hysteresis in the toothed cores and to extra eddy current loss in the solid field poles. The arrangement of the experimental apparatus was very convenient. The armatures, all of the same length and external diameter, ran in a field ring provided with interchangeable sets of poles, either 2, 4, 6 or 8 poles to a set. The drive was by a small motor, through a torsion dynomometer which indicated the power loss; the field poles were excited by a current which will be regulated to give successively increasing densities of magnetization. A special arrangement of bearings was used to detect changes in bearing friction, the bearing shell being itself mounted on a ball-bearing and held from rotation by a spring, so that a pointer attached to the shell showed by its movement any change in bearing friction.

"Central Station Economies," by Prof. W. E. Goldsborough and Mr. P. E. Fansler, dealt with the operation of the central station of the Union Traction Co. of Indiana, whose interurban railway line formed the subject of the two previous papers presented by the same authors at this convention. The central station supplies current for the operation of the entire system, some 100 miles of single track, and for this purpose is equipped with three 1,000-KW. engines and generators, one of which is for reserve. Eight water-tube boilers, each of 400 HP. rated, supply the steam. The tests show a high average efficiency of both engines and boilers. The boilers gave an efficiency of 79.6% from the coal pile, while the combined efficiency of main engines and auxiliary was 9.11%. The coal cost of the electrical energy generated, using Indiana block coal at $1.35 per ton delivered, figured out at 0.28 cts. per KW.-hour. The paper was somewhat criticised in the discussion, because it did not give the total cost of power, but only the coal cost; the coal cost alone, it was said, is of little value in judging the economical operation of a station. The point was also made that with a central station in which much refinement was introduced for economy a transmission line is used which gives only 50% efficiency.

Mr. R. L. Montague (Oroville, Cal.) presented a paper on "The Electrical Equipment of a Gold Dredge." Dredging river channels for gold enables vast deposits to be worked which hitherto have not been exploited. Electrical operation of such dredges is often economical and convenient. The current for the various motors is brought aboard by a cable attached to a transmission line along the shore. We shall print this paper in a later issue.

A paper by Mr. A. W. K. Pierce, entitled "Some Notes on Certain Underground Hoisting Problems on the Witwatersrand," was read by title. We expect to reprint it in a future issue.

An interesting piece of experimental apparatus was described by Prof. H. J. Ryan (Ithaca, N. Y.) in a paper on "The Cathode-Ray Alternating Current Wave Indicator." Magnetic fields act to deflect a stream of cathode rays; by mounting a small coil alongside the tube and near the path of the rays the deflection of the stream of rays will be proportional at any instant to the strength of the current in the coil. This cathode-ray "lever" has no appreciable inertia, and can therefore follow the highest frequency without lag or distortion. The rays fall on a fluorescent screen at the end of the tube and there produce a band of light, due to the oscillating motion of the stream of rays. By means of a second coil at right angles with the first, and a sine-wave current passed through this second coil, the band of light is resolved into a closed cyclic curve due to the combined magnetic field of the two coils. The scale of this curve in one direction being known (due to the sine-wave current) the irregularities in the current wave supplied to the other coil are shown by the irregular ordinates of the curve. The curve may be photographed by proper length of exposure (5 seconds). The discussion showed general appreciation of the apparatus and its possibilities. It was suggested that it may be found useful in investigating the commutator and brush phenomena in direct-current dynamos, or the oscillations occurring in high-tension transmission and in telephone lines.

JOINT SESSION ON EDUCATION.

On Friday morning, July 3, the American Institute of Electrical Engineers held a joint session with the Society for the Promotion of Engineering Education, at which only "education papers" were presented and discussed.

Prof. W. S. Franklin (South Bethlehem, Pa.) read a paper on "The Teaching of Physics to Engineering Students," which constituted essentially a vigorous protest against loose or speculative statements by text-books or by instructors. This kind of teaching is especially bad because the very object of the study of physics is to lead to a measured and quantitative appreciation of observed relations, or, as Professor Franklin expresses it, to produce "a determining objective constraint on the processes of the mind." A very general bad practice in laboratory work is thus characterized in the paper: "I think it is silly to talk of the verification of nature's laws by a student."

Mr. J. G. White (New York) outlined various requirements of modern engineering life in a paper on "The Problems That Are Facing the Electrical Engineer of To-day, and the Qualities of Mind and Character Which Are Needed to Meet Them." He also presented a sketch course of engineering, in several groups, primary, secondary, etc., according to their importance and order of selection. Special stress was laid on a full command of good and strong English, which should be considered as more important than any training in foreign languages. A thorough knowledge of arithmetic, with much mental drill, was emphasized as very important. Some practical ethical teaching was also included in the primary list. The author recommended that the young man desiring an engineering education should first decide on the length of time he will devote to it, and should then be given only that which is suitable to the time available. A plea was also made for cultivating the business sense of the student, as the engineer depends largely for success on the financier; tact should also be cultivated. Mr. B. Gherardi, Jr., presented a paper on "The Proper Qualifications of Electrical Engineering School Graduates, From the Telephone Engineer's Standpoint," which had as its main idea that the training of a future telephone engineer need not be substantially different from that given the electrical engineering student, the development of general engineering qualifications being the work of the school, while the acquisition of special knowledge is the work of the remainder of the lifetime. The training in English, to enable the young engineer, for instance, to write a correct, concise and logical report, was emphasized in this paper also. Not enough stress is laid throughout the schools and colleges on accuracy in work and calculations, which should be strongly insisted on. The paternal conditions existing in most laboratories, where the students go through a course of experiments almost mechanically, were sharply criticized. The same subject was argued from the manufacturer's standpoint in a paper by Mr. L. A. Osborne (Pittsburg, Pa.). The principal recommendation made in this paper was that much might be done in the college to give some instruction and training in shop methods, management, accounting, business practice as related to the shop, economics with reference to the relations between employers and employed, etc. The author says in closing:

> My plea is for engineers of broader horizons. Our technical schools to-day are admirably fitted to turn out men who are well grounded in the fundamentals of engineering. As a rule they are good mathematicians, electricians, chemists and physicists, and have all the technical knowledge necessary for pursuing the profession, but they are as a class woefully lacking in that they have no comprehension whatever of many of the subjects which are inseparably connected with the practice of the profession. I believe that much of the manual training which now occupies such a large proportion of the "actual hours work" in the courses of most technical schools could be replaced with profit by lectures on subjects related to those which have been mentioned in this paper.

In discussion of the preceding three papers (all written by practicing engineers) Prof. W. E. Goldsborough (Lafayette, Ind.) protested against practicing engineers presuming to advise professors how to teach, and claimed that it would be just as fair for professors to advise engineers how to do their work. The teachers of engineering have carefully studied the requirements and suit the instruction to these and to the needs of the entering students, while engineers can know only what results are desired in the graduate. He instanced military drill as an important requisite which engineers never thought of as being necessary. Prof. A. F. Ganz (Hoboken, N. J.) stated that Stevens Institute has for some time given a course in business engineering, with instruction in various business subjects. Prof. C. F. Allen (Cambridge, Mass.) said that the field of the college is to give theory, at all hazards, the experience and information to be acquired later in life. Some accompanying experience teaching is necessary to teach theory properly, and enough may well be given to make the student of some value to an employer, so that he may make a living while getting more experience. Employers should, in developing new men, put work on them just as they do on material, a thing few employers consider. He considered that manufacturers are in a better position to teach the young man something about accounting than are the colleges. Prof. H. S. Carhart (Ann Arbor, Mich.) thought that the college should make engineers, the qualifying adjective to this title to be put on by the subsequent career.

Similar ideas were expressed in a paper by Prof. D. C. Jackson (Madison, Wis.) on "Typical Electrical Engineering Courses." The purely descriptive should be avoided, in engineering courses, except as auxiliary to principle-teaching. Teachers in engineering schools are generally earnest and well-meaning men, but a great deal of such unsatisfactory conditions as still exist is to be charged to the fact that the executive heads of universities rarely have an adequate idea of what constitutes engineering. The author further outlined a course, having as principal elements (1) good expression in English, (2) drawing, (3) mathematics, (4) chemistry, (5) physics, (6) applied mechanics, together with a limited amount of manual training and surveying, and such information courses as there is room for. This and the following two papers were not discussed for lack of time. Mr. E. H. Mullin (New York) read a paper entitled "Training An Artist in the Forces of Nature," a scholarly plea for more sound food in education and less superficial and specialized imitation of practical life. The concluding paper of the session (and the convention) was by Mr. T. J. Johnston on "Engineering English." The author deplores the rarity of a good or even fair command of English by engineers of all ages, and gives a partial list of examples of bad or incorrect English which he has garnered from engineers' reports, etc., during the past year. Some of the most glaring solecisms, says the author, are from articles by professors in universities.

THE PHYSICAL PROPERTIES OF MALLEABLE CASTINGS, AS INFLUENCED BY THE PROCESS OF MANUFACTURE.*

By Dr. Richard Moldenke,† M. Am. Soc. M. E.

As the matter for specifications for cast-iron and finished castings is attracting considerable interest, it may perhaps be well to call attention to the necessity for a special clause in the one on "malleable cast-iron" limiting the processes allowable in its manufacture. The necessity for this action is the result of recent developments along the line of heat treatment given the hard castings.

As a general proposition it has been long known that the hard casting may be either annealed a long time at the regular temperature, or only a short time if the temperature be considerably higher. The results, while apparently the same, in that the combined carbon of the casting becomes the "temper carbon" characteristic of a good piece of "malleable," are in reality not so reliable as might be expected in the case of the higher heat. There are several processes now in use which aim to reduce the period of anneal, to cheapen the cost and to make quicker deliveries. Unfortunately, however, whether from an insufficient knowledge of the science of heat treatment, or from a lack of uniformity of material, the castings produced are not always good "malleable," and lead to much loss and annoyance.

Until we know more of the behavior of the iron going into the malleable casting when heated beyond the ordinary annealing temperatures it would be well to call for a minimum number of hours during which the work to be tested for acceptance has been given the full heat of the ovens. For light work this might be placed at 60 hours, and for ordinary or heavy material at 72. When the makers of malleable castings who anneal their work a few hundred degrees higher and thus shorten the period can prove to the buyer that they can do this successfully every time, this clause relating to length of time under full heat can be modified or done away with. So far, however, these varieties of the malleable casting seem to be sold as steel, and very likely to consumers who cannot tell the difference.

For the benefit of the foundry industry it is to be hoped that the heat treatment of the malleable casting be thoroughly investigated, and on a commercial scale. Much of value would be learned this way, and the spasmodic attempts to reduce the cost of annealing by varying the method of carbon conversion be brought down to a scientific basis, and subsequent business results.

In addition to the annealing question there must be considered the melting process to be followed. Three methods are now in use here. The cupola, air furnace, and the open-hearth processes. Lately a modification of the Bessemer process is being introduced, but is too new to be taken into account yet. The crucible process, which undoubtedly gives the best results is obsolete in this country. Contact with the fuel during melting cannot do otherwise than injure metal so low in silicon as this must be, and hence the cupola process gives the poorer grade of "malleable," the higher annealing temperature required not improving matters either. For important work this class of malleable is always excluded. Where, however, there is no necessity to resist shock, and the factor of safety is amply large there is no reason why cupola malleable should not be used, and about a half a cent or so a pound be saved.

As between the air furnace product and that of the open-hearth, the latter, when produced properly, is undoubtedly the best, and the industry is gradually working in that direction. The expression "produced properly" is used advisedly, as the mistake of using steel melters for getting out "malleable" heats is made only too often. The result is an attempt to get a reaction between the oxygen introduced with the carbon of the bath with the result that the former remains and poor iron results. The malleable process should not be made a refining process, in spite of the prevalent theories to that effect. The reduction of the total carbon undoubtedly improves the tenacity of the castings, but this is best accomplished by the addition of steel scrap. The temperature of the melt is unfortunately not sufficient, even in the open-hearth furnace at the time of pouring to bring about the carbon-oxygen reaction completely, and hence the metal is affected injuriously. Were it steel the addition to ferro-manganese would soon mend matters, but unless to remove undue sulphur this should be kept away from "malleable."

A plentiful application of muscle to get a quick even melt is what is wanted for malleable work, and hence while it is good to have an open-hearth expert about to preserve the furnaces, he should not run the heats, a muscular "Hungarian" doing much better.

The air furnace product, though not so good as that of the open-hearth, on account of the longer duration of the melting period, is nevertheless serviceable for the best class of work, and hence no distinction need be made in drawing up specifications. Attention to this difference is only called here to benefit those who may have trouble with their installations. Personal experience with both classes of castings for many years would indicate that the open-hearth material has the advantage over the air-furnace produce by about 2,000 lbs. per sq. in. in tensile strength, this figure being the average taken from a large number of samples cut from castings of both kinds. As, however, it is undesirable to run the tensile strength too high, say not over 52,000 lbs per sq. in. or thereabouts, and air furnaces iron can be made to touch this point readily, there is no immediate cause for worry. A moderately strong iron is in fact better able to resist shock, and therefore specifications should only give the minimum tensile strength, say 40,000 lbs. per sq. in. The highest obtainable has reached 63,000.

The near future will doubtless bring out much on the process question in malleables, and indeed, a good set of specifications covering the best present practice will do much to hasten it on.

*A paper read at the annual meeting of the American Society for Testing Materials.

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ANNUAL CONVENTION OF THE MASTER CAR BUILDERS' ASSOCIATION, SARATOGA, N. Y.

The annual convention of the Master Car Builders' Association for 1903 was held June 29 to July 1 at the Grand Union Hotel at Saratoga, N. Y. There were three sessions, and the program comprised some 30 papers, special committee reports, and topics for formal discussion. The limited time gave opportunity, however, for only a portion of the topical subjects to be considered. As a rule the committee reports were of notable merit, and they deserved all the attention that they received. There was considerable time wasted in presenting some of the reports in detail, and in allowing discussion to wander to trivial matters and stretch out to an immoderate length. The Rules of Interchange aroused more discussion than during any convention for some years, but when finally adopted stood about as they were, no important changes having been made. The attendance was large, and considering the 4½-hour continuous sessions, which encroached well onto the lunch hour, it was well maintained in the meetings.

Opening Session.

The convention opened with the usual addresses of welcome and response, followed by the formal address of the President, Mr. J. W. Marden (B. & M.). Mr. E. A. Moseley, the Secretary of the Interstate Commerce Commission, then addressed the meeting on the various features of the new safety appliance act. The Secretary's report showed a total membership of 534, and that the finances of the Association were in good condition. The annual dues were made $3. At the convention of 1902 the following amendment of the constitution was submitted for vote at the convention of 1903:

> Any person holding the position of superintendent of the car department, master car builder, mechanical engineer, foreman of railroad car shop, joint car inspector, or one representative from each car manufacturing company or other company owning over one thousand cars, which are not in process of purchase by other parties, may become an active member by paying his dues for one year. Unless expelled from the association his membership shall continue until after his written resignation is received by the secretary.

This amendment was adopted by vote of the convention. The following further amendment was proposed by the Executive Committee for consideration and vote at the convention of 1904:

> Any person having a practical knowledge of car construction may become a representative member by receiving a written appointment from the president, general manager or general superintendent of any railroad to represent its interests in the association.
>
> Similarly, any person having a practical knowledge of car construction, may become a representative member from a private car company by presenting a written appointment from the president, vice-president or general manager of the company; provided, that said company owns or operates one thousand cars or over.
>
> Such member shall have all the privileges of an active member, including one vote on all questions, and in addition thereto shall, on all measures pertaining to the adoption of standards or the expenditure of money, have one more vote for each full one thousand cars which are owned, or which are in use or process of purchase by the road, system or private car company which he represents. His membership shall continue until notice is given the association of his withdrawal, or of the appointment of his successor.
>
> No railroads or system of roads or private car lines under one general manager or general superintendent shall have more than one representative member.
>
> In the enumeration of four, six, eight or more wheeled cars, four axles to count as one car.

On motion of Mr. W. C. Squire (St. L. & S. F.) a committee was ordered to be appointed to confer with the Interstate Commerce Commission in the decision of points of recommended practice and standards of the M. C. B. Association. The reports of the standing committees on Brake Shoe Tests and Tests of Triple Valves were then presented. Both were short, the former announcing the results of tests made on two brake shoes and the latter stating that no triple valves had been submitted for test during the year.

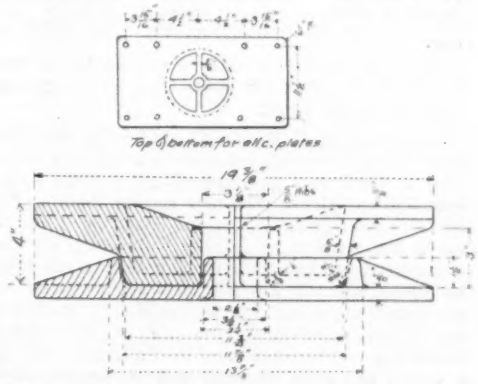
Mr. Angus Sinclair read the same paper on the Metric System which he presented before the Master Mechanics' Association the preceding week and offered the following resolutions which were adopted without dissent:

> Whereas, A bill for the adoption of the metric system in the departments of the Federal Government has been reported favorably to the House of Representatives;
>
> Whereas, We consider that the only effect of such a law will be the creation of a government metric system and the continuation of the existing system in ordinary commerce and industry;
>
> Whereas, We believe a change in the system of weights and measures used by the people at large to be impossible;
>
> Whereas It is evident that the confusion resulting from such a condition of things would be intolerable; therefore be it
>
> Resolved By the Master Car Builders' Association, in convention assembled, that we condemn all legislation intended to promote the adoption of the metric system in this country;
>
> Resolved That we especially condemn the bill which was reported to the last House of Representatives as one which can do nothing but introduce confusion where we now have uniformity.

Middle Session.

The session opened with the presentation of the report of the Committee on Standards and Recommended Practice, and a letter from Mr. Geo. Gibbs was read calling attention to the necessity of studying the question of car clearances in relation to the electrification of terminal and branch lines. Many of the cars now being built encroach upon the track clearance so greatly that the location of the third rail is a difficult problem. The special committee reports were then proceeded with and their consideration occupied the remainder of the session, except for the time allotted to the discussion and revision of the Rules of Interchange.

SIDE BEARINGS AND CENTER PLATES.—The committee having this subject presented an elaborate report describing the large number of



Form of Center Plate Recommended by Committee of Master Car Builders' Association.
(Area of Contact Faces 100 sq. ins.)

tests which it had conducted on center plates and side bearings of various forms. Its conclusions from the tests made were as follows:

> In summing up the results obtained, the minimum flange resistance was obtained with the flat plate, Fig. 1, of chilled cast-iron. The projected area of this plate was 100.14 sq. ins. In order to determine the best size of this plate, six different plates were constructed, ranging in area from 100.14 sq. ins. to 46.793 sq. ins. The results obtained are so close that it is difficult to say which will be the best area to adopt. Apparently, the flat plate with an area of 86.738 sq. ins., using as a basis a smooth casting, no lubrication, gave the best general results, and a flat plate of this description is recommended to the Association as the standard form of center plate.
>
> Two ball-bearing center plates were tried. These center plates gave such remarkable results that there can be no question of a reduction in flange resistance by their use. One road has been using for a number of years now a ball-bearing center plate, and in so far as durability is concerned, the plates are reported as giving entire satisfaction. It is recommended to the Association that during the coming year the members equip a number of cars with ball-bearing center plates, in order to ascertain more fully their durability.
>
> A number of side bearings were also tried, but these experiments could not be completed, as, in order to test the different makes, it would have been necessary to reconstruct the machine, which time would not permit. In so far as the tests were carried out, however, the results indicate very much less flange resistance with the roller side bearings than with the ordinary flat cast-iron plate. On account of the inability to thoroughly test out the side bearings, the recommended distance from center of

center plate to center line of side bearing was not obtained. Replies from various members of the Association indicate this distance to run from 24 to 32½ ins. In the tests as conducted the distance was taken as 25 ins.

While the committee recommends to the Association a standard form of center plate, as Fig. 1, there is no doubt in the minds of the committee that if the ball-bearing center plates and side bearings are durable in service a very greatly decreased flange resistance will be obtained.

The only discussion was by Mr. R. P. C. Sanderson, who stated that the drawings of Fig. 1 were too incomplete to be of service and requested that the committee be instructed to furnish a complete and full contour outline of the plate recommended.

CAST-IRON WHEELS.—This committee had for its duty the designing of cast-iron wheels suitable for cars of 60,000, 80,000 and 100,000 lbs. capacity. The report outlined the methods adopted by the committee in arriving at its conclusion and then said:

Fig. 1 shows the recommendations of your committee for hub lines, ring, core, flange thickness and tread. It will be noticed there is a slight change recommended in the tread at the throat of the flange and on the outside of the flange. This change in the throat is not a new idea, but has been in use on a good many roads for several years and all of the reports your committee have received on this question favor its adoption. As the greater radius throws the rail wear farther from the flange reducing wear at the throat, increases the thickness of metal where it is most needed, has a tendency to make a smoother casting and has been demonstrated by experience to be satisfactory in service, it seems a proper change to make in the interest of flange protection. The suggested changes in hub lines are made to meet the turning points of the Standard Car Axle as adopted by this convention in 1902 and which are already adopted by a number of roads. Your committee recommends the following weights of wheels: For cars of 60,000 lbs. capacity, 600 lbs.; for cars of 80,000 lbs. capacity, 650 lbs.; for cars of 100,000 lbs. capacity, 700 lbs., with a minimum weight allowed in interchange of 580, 630 and 680 lbs., and further recommend that all wheels cast in the future have their normal weight cast on the outside plate in figures not less than 1¼ ins. long and ⅛-in. high. It is the further recommendation of your committee that the present wheel specifications be changed to include the weights adopted for wheels for 60,000, 80,000 and 100,000-lb. cars; that they require the normal weight of the wheel cast on the plate in letters not less than 1¼ ins. long; that the amount of old wheels allowed in mixture be not more than 60% of the total charge; that the chill be not less than ½-in. or more than 1 in. in the tread or throat; that the drop test be changed to make the test a failure if the wheel cracks, checks or breaks, in the flange, ribs or plate, and that the test shall be 10 blows of the 140-lb. weight falling 12 ft. for 600-lb. wheels or wheels for 60,000-lb. cars; 13 ft. for 650-lb. wheels or wheels for 80,000-lb. cars, and 14 ft. for 700-lb. wheels or wheels for 100,000-lb. cars.

The only discussion was on the motion of Mr. A. M. Waitt, that the committee be continued; this was finally voted.

TESTS OF M. C. B. COUPLERS.—The standing committee on this subject made a rather elaborate report, which was accompanied by a large number of illustrations. The new testing machine for couplers has been designed and constructed and is ready for erection at Purdue University; an attachment has been built for the testing machine by which separate knuckle tests are possible; no recommendation can yet be made of a standard uncoupling attachment; the use of the solid knuckle is recommended and in connection with it a device has been invented and is recommended for handling cars around sharp curves; a slight modification of contour is suggested, and a complete new specification is offered. Referring only to the proposed new contour and to the new specification, the two distinct features involved in the proposed contour are, first, that the knuckle is made more hook-shaped; and, second, that about 3-32-in. is gained across the contour at the pivot pin-hole; the new specification is in full as follows:

The couplers furnished under this specification must be made of steel in accordance with the best foundry methods and must not be painted.

1. Couplers will be subject to the inspection and test of the above named company as to their mechanical workings, general condition and strength. The tests and inspection will be made at the place of manufacture, where assistance and labor necessary to make satisfactory and prompt inspection and shipment must be furnished free by the manufacturer. The testing machine and gages approved by the M. C. B. Association must be used in the test and inspection of couplers.

2. Couplers will be ordered as far as practicable in lots of 1,000; for each 1,000 ordered the manufacturer shall furnish 1,015, and in the event of additional couplers being required to carry out the prescribed tests, they shall be furnished free of cost by the manufacturers.

3. Bars, knuckles and locking pins or blocks must be accurately made to gages furnished by the manufacturer. These gages must govern all dimensions representing fitting surfaces, thereby insuring absolute interchangeability and freedom of motion between the assembled parts without further adjustment or machining. When assembled, knuckles and locking pins or blocks must work freely, but the lost motion between knuckles and bars must not permit more than ⅛-in. vertical play, or between knuckles and locks must not permit the knuckle to drop forward beyond the proper contour line, but ¼ or ⅜-in. lost motion in opposite direction is desirable.

4. Couplers must conform to M. C. B. contour lines and must have a lock set within the head of the coupler. They must couple and uncouple with each other (with either or both knuckles open) and also with the master or sample coupler; they should lock easily when the knuckle is pushed in by hand. They must, unless written permission to the contrary be given, have steel pivot pins 1⅝ ins. in diameter of sufficient length to permit applying a ⅝-in. cotter pin through the pin below the coupler lug. Pivot pins, after having the heads struck up, must be properly annealed.

5. Bars and knuckles shall not be accepted if distorted by improperly matched flasks or any other defects due to molding. They must be free from injurious shrinkage cracks, flaws, checks, sand, sand holes or blow holes. The holes for pivot pins in lugs of bars and knuckles should be drilled or, if cored, must be broached out, and must not be more than 1-16-in. larger than pin. The holes must be parallel to the face of the bar or knuckle and at right angles to the axis of bar or knuckle. As many bars and knuckles as possible must be cast from the same heat of steel. All parts must be well annealed throughout.

6. The pulling and contact faces of coupler and knuckle must be clean, smooth and at right angles to axis of the bar. The dimensions of butt and shank must be within the limits of variation shown by the company's drawing.

7. The name of coupler must be legibly cast on the top side of head of the bar. Each knuckle and each drawbar must bear a serial number legibly stamped or cast upon it. The knuckle must also bear the name of the coupler and the manufacturer's name or identification mark legibly cast or stamped at some point where it will not be worn off.

INSPECTION.—1. The couplers, after having been thoroughly inspected by the manufacturer to see that they meet the requirements as to interchangeability, soundness and dimensions of parts, etc., herein specified, should be arranged in lots of 101 and 102, so as to provide for the necessary 1,015 couplers and, where possible, care should be taken to put all couplers of the same heat number or numbers in the same lot or lots. The inspector shall then inspect and gage each coupler as to its compliance with drawing sizes, and for surface defects and proper contour lines. Any irregularities or swollen parts on the working or bearing faces must be ground or chipped off before the couplers are accepted.

After this inspection the inspector shall select one complete coupler taken at random from each of the lots as provided for above and subject them to Test No. 1, hereafter specified. If the coupler fails to stand the prescribed tests but, before failing, stands a sufficient number of blows to make a retest admissible, a second coupler shall be taken from the same lot from which the first coupler was taken. If it stands the test, that lot of couplers shall be accepted as far as test No. 1 is concerned; otherwise that lot of couplers shall be rejected and another lot substituted and tested in the same way.

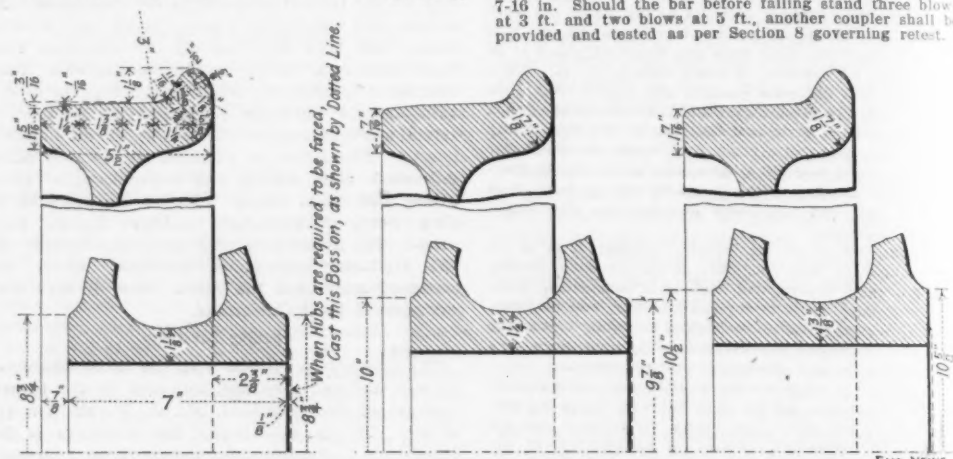
2. From each 1,005 couplers accepted by test No. 1 five complete couplers shall be selected by the inspector, one of which shall be subject to test No. 2, two to test No. 3 and two to test No. 4, hereafter specified. If any coupler or pair of couplers fails to stand the prescribed test but, before failing, stands a sufficient number of blows to make a retest admissible, a second coupler or pair shall be taken from the same lot or lots from which the first were taken. For instance, if the couplers selected for the test No. 3 have been taken from the fourth one hundred couplers and the failure allows a retest, a second pair shall be taken from the fourth one hundred couplers. If they stand the test, that lot of one thousand couplers shall be accepted as far as that test is concerned, otherwise that lot shall be rejected and another lot of one thousand couplers substituted. Any part of any coupler which has been subjected to test is condemned for service.

PHYSICAL TESTS.—Test No. 1; Striking Test on Closed Knuckle of Complete Coupler: As a preliminary, the coupler must be marked on bottom of butt with a center-punched line parallel to axis of shank, this line to extend to the inner face of knuckle; the coupler must then be rigidly fixed in the machine in a vertical position, with the axis of coupler in the center line of drop, the pivot pin hole parallel to line through center of legs of the machine and the butt blocked solidly on the anvil to prevent lateral motion by means of steel filiers and wedges, the latter sledged down tight and this sledging repeated after each blow. The heights of support from bottom of butt end should not be greater than 19½ ins. Blows to be struck directly on knuckle. Three blows of 1,640 lbs. falling 5 ft. Three blows of 1,640 lbs. falling 10 ft.

The coupler shall be considered as having failed to stand this test if it is broken before it has received three blows at 5 ft. and three blows at 10 ft., or if any cracks appear more than 1 in. long or open more than 1-16 in. or the center-punched line measured at contour is distorted more than 1⅛ ins. after having received three blows at 10 ft., or if the knuckle is closed more than ¾ in. from its original position when pulled out against the lock by hand after receiving three blows at 5 ft., or if the knuckle will not open, or if the locking device is inoperative after test. Should the coupler before failing stand three blows at 5 ft. and one blow at 10 ft., another complete coupler shall be provided and tested per Section 8 governing retest.

Test No. 2; Guard Arm Test of Drawbar: As a preliminary, pivot, knuckle and locking device having been removed, the coupler must be marked on bottom with a center-punched line parallel to axis of shank and extending to the contour face, a center-punch mark must also be placed at the end of guard arm and on lug. The coupler must be blocked rigidly in a vertical position in the machine with steel fillers and wedges, the latter sledged down tight and the sledging repeated after each blow. The butt must rest solidly on the anvil and must be blocked to prevent lateral motion. The edge of guard arm must be on line through centers of legs of machine. Blows to be struck directly on guard arm. Three blows of 1,640 lbs. falling 3 ft. Four blows of 1,640 lbs. falling 5 ft.

The coupler shall be considered as having failed to stand this test if it is broken before it has received three blows at 3 ft. and four blows at 5 ft., or if any crack appear more than 1 in. long or open more than 1-16 in., or if the center-punched line is distorted more than 1½ ins. for 5 in. by 7 in. shank or 1⅞ ins. for 5 in. by 5 in. shank couplers, or if the distance between center-punch marks on bottom of head has widened more than 7-16 in. Should the bar before failing stand three blows at 3 ft. and two blows at 5 ft., another coupler shall be provided and tested as per Section 8 governing retest.



A. 600 lb. Wheel for 60,000 lbs. Capacity Cars.
B. 650 lb. Wheel for 80,000 lbs. Capacity Car.
C. 700 lb. Wheel for 100,000 lbs. Capacity Car.

DIAGRAMS SHOWING DIMENSIONS OF CAST-IRON WHEELS FOR 60,000-LB., 80,000-LB. AND 100,000-LB. CARS, PROPOSED BY MASTER CAR BUILDERS' COMMITTEE.
(The dimensions not repeated on "B" and "C" are identical with those given on "A.")

Test No. 3; Jerk Test of Complete Couplers: Two couplers shall be placed in an inverted position in the yoke forging of test machine and equalizer bar placed so as to rest on the closed knuckles. The weight must strike the equalizer bar midway between the two couplers. Three blows of 1,640 lbs. falling 5 ft. Three blows of 1,640 lbs. falling 10 ft.

A coupler shall be considered as having failed to stand this test if it is broken before it has received three blows at 5 ft. and three blows at 10 ft., or if cracks appear more than 1 in. long or open more than 1-16 in., or if the knuckle is open more than ¾ in. from its original position after third blow at 10 ft., or if the equalizer bar will not stay in place when struck, or if the knuckle will not open, or if the locking device is inoperative after receiving the full test. Should either or both couplers fail to stand the prescribed test, but stand two blows at 5 ft. and 1 blow at 10 ft., another complete coupler or pair of couplers shall be provided and tested as per Section 8 governing retest.

Test No. 4; Pulling Test for Complete Couplers: Two couplers shall be supported in the machine by yoke forgings and locked together as in running position, with their axis in the same straight line. The couplers must stand a steady pull of 120,000 lbs. A coupler shall be considered as having failed to stand this test if it is broken before it has been pulled the prescribed number of pounds, or if any cracks appear more than 1 in. long or open more than 1-16 in., or if the knuckle has opened more than ¾ in. from its original position when pulled out against the lock. The measurement of knuckle opening must be obtained after the pressure is released. The couplers shall be considered as having failed to stand this test if they slip apart in the machine, or if the knuckle will not open, or if the locking devices are inoperative after above tests. Should either or both couplers fail to stand the prescribed test, but both stand 90,000 lbs., another complete coupler or pair of couplers shall be provided as per Section 8 governing retest.

The final failure of any part to meet test shall not condemn the complete coupler but only that part which fails, and such part in all couplers presented shall be replaced, after which the test shall be proceeded with, using new couplers, as if no part of the test had been made.

Closing Session.

COLLARLESS JOURNALS.—The Committee on Collarless Journals presented a brief report in which it was stated that 31 members replying

to a query had stated that only 2% of their freight and 15% of their passenger cars are equipped with collarless journals. The Committee expressed the opinion that the M. C. B., or collar type of journal, is almost a necessity to insure intelligent inspection and proper care of the packing in the journal boxes. Moreover the excessive end play with the collarless end journal, bringing the load farther from the fulcrum, causes a greater strain on the axle than with the collar journal where the end play is limited.

Mr. D. Van Alstyne moved that the Pullman Co. be urged to change their standard as soon as possible from collarless journals, and adopt the M. C. B. coupler. The motion was carried.

Quite a long discussion on the report of the Committee on Tests of M. C. B. Couplers followed, the main point of discussion being the allowable play in pivot pin-holes. There was opposition to increasing the allowable size of pine-hole, and certain members urged that the holes be drilled so as to give a close fit.

OUTSIDE DIMENSIONS OF BOX CARS.—The Committee on Outside Dimensions of Box Cars submitted with its report drawings of proposed box car framing; and as to dimensions the following recommendations were made:

1. That the inside dimensions of box cars as approved by the American Railway Association, namely 36 ft. long, 8 ft. 6 ins. wide, and 8 ft. high, be submitted to letter ballot for adoption as standard.
2. For box cars on high trucks (4 ft. to top of floor): Height, top of rail to upper edge of eaves, 12 ft. 6¾ ins.; width at eaves, at above height, maximum 9 ft. 7 ins.
3. For box cars on low trucks (3 ft. 6 ins.): Height, 12 ft. ¾-in.; width at eaves, max., 9 ft. 7 ins.
4. That the words and letters "Standard 12 ft. 6¾ ins. by 9 ft. 7 ins." be stenciled in three-inch letters on the end fascia boards on all cars built to these dimensions.

In discussing the designs submitted by the Committee, Mr. W. F. Bentley objected to the diagonal bracing in the roof. On the Baltimore & Ohio such bracing had been used, and in running over severe grades it had proved a very bad design. There is such a thing as getting too stiff a roof, resulting in cutting the nails off and racking the roof all to pieces. The trouble came after the timber had shrunk.

STEAM AND AIR LINE CONNECTIONS.—The Committee on Steam and Air Line Connections had conducted a series of tests on the heating of a train of 16 cars during the months of February and March, at Collingwood, Ohio. The report gave at great length the method of conducting the tests and the results. In view of the longer passenger trains now so common the Committee recommended for adoption the following:

Two-inch. steam train pipe; end train pipe valves; steam hose, 1¾ ins. inside diameter and of such length as to provide 31 ins. from face of coupling gasket to end of hose nipple; 1½-in. steam hose couplings with gaskets having 1½ ins. diameter opening, gaskets to be so constructed that the normal diameter of opening will always be maintained; couplings not provided with gravity traps; inlet valves to have reduced openings which should be as small as possible and maintain the volume of steam required by the radiating pipes for the severest weather conditions, steam heat, air brake and signal connections to be located as shown on diagram; air brake and air signal hose to be 1-in. diameter and 22 ins. long.

Of 29 roads that reported practice only one is using 2-in. steam train pipe, the others using 1½-in. pipe, but the committee calls attention to the fact that this smaller pipe was adopted at a time when trains consisted of six or eight cars.

SIGNAL-LAMP BRACKETS AND SOCKETS.—The Committee on Signal-Lamp Brackets and Sockets recommends:

that all signal-lamp brackets and sockets should be located on the body corner posts of all open and narrow vestibule cars, and on vestibule corner posts of all wide vestibule cars at a distance of 5 ft. from bottom of side sill to center of signal-lamp bracket or socket and as near center line of corner post as possible, but owing to the different widths of cars, lamp-bracket arms, etc., it will be found some roads will have to shift brackets slightly from center line to suit conditions.

OTHER COMMITTEE REPORTS.—The Committee on Proposed Standard Pedestal and Journal Box for Passenger Cars for 5 × 9-in. Journals submitted designs without verbal comment.

The Committee on Car Lighting had no recommendations to make.

The Committee on Standard Requirements for High-Speed Foundation Brake Gear for Passenger Service submitted designs made by Mr. J. A. McRae, who is connected with the office of the Mechanical Engineer of the N. Y. C. & H. R. R. R.

The Committee on The Proper Design and Construction of Tank Car Equipment did not have any advance copies of their report, which was presented by Mr. C. M. Blaxham.

NEW OFFICERS.—The final business of the session was the election of officers. The Committee on Nominations presented the following list of officers of the Association for the year 1903-1904:

President, F. W. Brazier.
First Vice-President, W. P. Appleyard.
Second Vice-President, Joseph Buker.
Third Vice-President, W. E. Fowler.
Treasurer, John Kirby.

Members of the Executive Committee, D. F. Crawford, J. T. Chamberlain and J. S. Chambers. To fill the unexpired term of L. T. Canfield, T. S. Lloyd.

The Secretary was authorized to cast the ballot of the Association for the nominees named.

URBAN RAILWAY TRANSPORTATION in New York city for the past year aggregated 410,414,064 passengers, which represents an increase of about 8% over the number carried in the preceding year. This figure covers the business of the elevated lines and the surface street-car lines in all the boroughs of the city.

THE COLORADO STATE CAPITOL, at Denver, has been finished after 13 years of work. All the material in it, even to the marble wainscoting, has been quarried within the state. Unlike other capitols, the building faces the west, in recognition of the mountains that have made Colorado the commonwealth that it is. Some $3,000,000 have been expended on the capitol, and a few voices are now heard bewailing the fact that $2,000,000 more must be paid out in interest on the bonds during the next 40 years. Even taxpayers like to eat their pudding and yet have it.

RAILWAY TRACK REPAIRS AND TRESTLE BUILDING UNDER WATER ON THE VANDALIA LINE.

By H. I. Miller.*

The water in the Mississippi River showed 38 ft., on the Government stage, on June 10, 1903, the highest water since 1844. This was accompanied by the river cutting through the levees on the east bank at points several miles above, and the water pouring through these breaks at the higher level reached our tracks east of Willows, 1.8 miles east of the Relay Station, at a 39.9 stage, cutting out our embankment at several places, and covering the tracks for miles. The principal break was near the Willows interlocking tower, east of the crossings of the Illinois Transfer and the Southern Railways.

The construction trains working westward were able, through reballasting, lining, and surfacing three-quarters of a mile of track under 12 to 15 ins. of water, to reach Willows Saturday morning, June 13. The water then stood about 15 ins. over the rail at that point.

It was decided not to wait for the water to recede to bridge a gap of 45 ft., but to construct this bridge under water. The bottom of the washout was from 20 to 25 ft. below the surface of the water. A bent of piles was driven to the surface of the water and then followed down 4½ ft. The cap was drifted to the top of the piles by use of a 2-in. pipe, through which the drift bolts were followed to place.

The track was blocked up on this cap, and the driver moved forward and another bent driven and capped. With blocks and jacks the suspended rails and ties were raised enough to permit of putting the stringers in place. These were then drifted after the manner described above, and the track drifted to the stringers. In all, five bents were driven.

Row boats and timber rafts were used in delivering the material to the men at the bridge, and regular shifts were made of the men working in the water. The new bridge under water was ready for use at one o'clock Sunday, enabling us to open the road to its regular traffic that morning at eleven o'clock.

Those directly in charge of the work, and to whom the credit is due, were Superintendent W. C. Downing, Engineer Maintenance of Way; Maurice Coburn, Master Carpenter, and A. W. Coffin, his foremen, and the bridgemen who were in the water.

The pile driver was equipped with a drop hammer, the blow of which, however, was so nicely adjusted as to permit of driving to one level the tops of all the piles in the several bents.

*General Manager, Terre Haute & Indianapolis R. R. Co., St. Louis, Mo. (Mr. Miller very kindly contributed this account of repair work under difficulties, at our request.—Ed.)

THE PROPOSED BROOKLYN BRIDGE TERMINAL AND NEW YORK MUNICIPAL BUILDING.

Through the courtesy of the Hon. Seth Low, Mayor of New York city, we are enabled to present herewith advance copies of the plans for the great terminal and municipal building, designed by Bridge Commissioner Gustav Lindenthal, assisted in the architectural features of the design by Mr. Henry F. Hornbostel, with Mr. George B. Post in consultation.

As most of our readers know, the congestion of traffic at the present City Hall Station of the Brooklyn Bridge is not equaled elsewhere in the world, and when the Rapid Transit Railway reaches completion the congestion will be far worse. Mr. Lindenthal has planned a great terminal station that will accommodate not only the trains of the Second and the Third Ave. Elevated roads, the bridge trains from Brooklyn Bridge and the new Manhattan Bridge, but also the present surface trolley lines and those crossing the bridge. A short distance from the terminal building itself, as shown in Fig. 1, are the stairways leading down to the Rapid Transit station.

Fig. 1 is a plan of the third level of the terminal, and it will be noted that the tracks of the Second Ave. Elevated Railway, here shown, are above those of the Second Ave. Elevated shown in Fig. 2.

Long "dash and dot" lines indicate buildings to be removed; short-dash lines indicate parts of present terminal to be removed.

Fig. 2 is a plan of the building, showing the second level with the first or ground level beneath it. It will be noted that Chambers St. and Park Row pass through arcades, while the trolley lines from the bridge make ten loops on the ground level; six of these loops lie beneath the second floor and are indicated by long-dash lines.

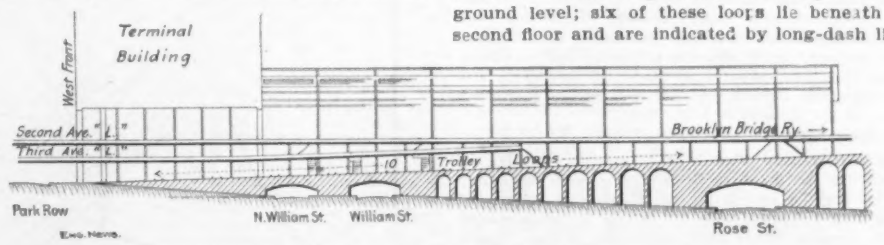


FIG. 3. LONGITUDINAL SECTION OF BROOKLYN BRIDGE TERMINAL STATION.

The cross-section, Fig. 3, brings out clearly the position of the tracks in the three stories or levels.

The proposed tracks from Brooklyn Bridge, it will be seen in Fig. 1, form a loop connection with those of the new Manhattan Bridge. Between Chambers and Duane Sts. there will be a rectangular tower-like structure rising 43 stories to a height of 650 ft. This part of the building is termed the Campanile, and is designed to contain offices.

Mr. Lindenthal's estimate of the cost of the terminal and city hall is $9,025,825, about half of which is for land; and his report, as submitted to the Board of Estimate is in part as follows:

From this spot in New York—in front of the Brooklyn Bridge—less than one acre in area, radiate, as from a hub, railroad lines in all directions, which carry about 150,000,000 passengers per annum.

When the presently planned transportation lines are completed, about another 150,000,000 of passengers will have to be accommodated, or about 300,000,000 passengers in all. It is now and will be for a long time the most densely traveled spot on the face of the globe.

A station problem, therefore, at this point presents unprecedented conditions and difficulties; for which I believe a good solution has been found in the plans herewith submitted to you.

The engineering and transportation questions were, however, not the only thing to be considered.

The entrance to the Brooklyn Bridge has long been a disgraceful eyesore—a collection of dingy makeshift structures. Every one feels that the pride of the city cannot suffer them to remain.

The new City Hall station can be made the means for correcting this evil. To that end the architectural features of the station were carefully studied; and an attempt is made in the plans submitted to you to bring them into æsthetic harmony with the architecture of the new Hall of Records—an immediate neighbor. For these features I had the assistance of Mr. Henry F. Hornbostel, as the designing architect, and that of Mr. George B. Post, as the consulting architect.

Confining the plans strictly to the scope of your resolution, the several parts of the station and their capacity will be here briefly described:

(a) Basement:

The present subway station with the present entrances and exits from the streets, will remain unchanged, but additional platform space will be given, and additional stairs will connect that station with the street level, and with the subway station of the Centre St. and Park Row subways. There will, therefore, be three subway stations in one combination. Passengers from any one will be able easily to reach the other subways or the street level. The passages are to be all very spacious, and the stairways wide and of easy rise.

With a prompt movement of cars on all subway lines, about 100,000 passengers per hour will be able to use the basement stations. Under this basement will be located a sub-basement, containing all the necessary machinery for the lighting and heating of the bridge station building, and for the elevators, boilers, etc.

(b) Ground Floor:

Chambers St. and Park Row are bridged over by the station building. Surface car tracks are rearranged for easier connection of lines on Center St. with those on Park Row.

William St. is straightened so it may form a continuous thoroughfare with Center St.

The sidewalks are placed in arcades from which the stairways lead to the first level above.

On this floor are the ten trolley loops for the surface cars to Brooklyn.

Also elevators to offices on upper floors. The whole area from Duane St. to the Bridge, required as shown on ground floor plan. The room at the ten trolley loops (which are spaced forty feet apart) will be five times greater for the accommodation of the crowds than at the present four loops, which are but twenty feet apart.

(c) First Floor:

This is set aside for the Manhattan Elevated Railroad terminal for its Third and Second Avenue trains; the four tracks and five platforms admitting of sixty six-car trains arriving and departing every hour; or, about 30,000 passengers arriving and 30,000 passengers departing each hour. Incoming and outgoing passengers do not come into collision, having separate platforms and stairways.

Connection with the trolley loops by stairways, also with City Hall Park by gallery and bridge over Park Row.

(d) Second Floor:

This shall remain what it is at present; namely, the terminal for the Brooklyn Bridge trains, with tail-switch curving into the station for the Manhattan Bridge and having loop connection with it. In fact, a double station for the elevated trains from Manhattan Bridge. Trains can pass either way through the stations, as through trains, or return over the same bridge by which they came. The capacity of each station is sixty trains of six cars each, in each direction, per hour, or, 60,000 passengers arriving and 60,000 departing hourly, from the two stations. The stairways and platforms will be proportioned to that traffic.

(e) Five Office Floors:

Above the station floors are five office floors of 36,000 sq. ft. each, or about 180,000 sq. ft. together, including the Campanile up to the roof line of the bridge station, which is on a level with the roof line of the Hall of Records.

At $2.00 per sq. ft., the rentals for 180,000 sq. ft. would equal $360,000, saved from the rent roll of the city.

The manner in which the bridge station will serve also as terminal for the Manhattan Bridge and for the subway connection with that bridge and with the Williamsburg Bridge will be discussed in a separate report which I am preparing on the question of connecting the four East River bridges with the passenger transportation systems on both sides of the river.

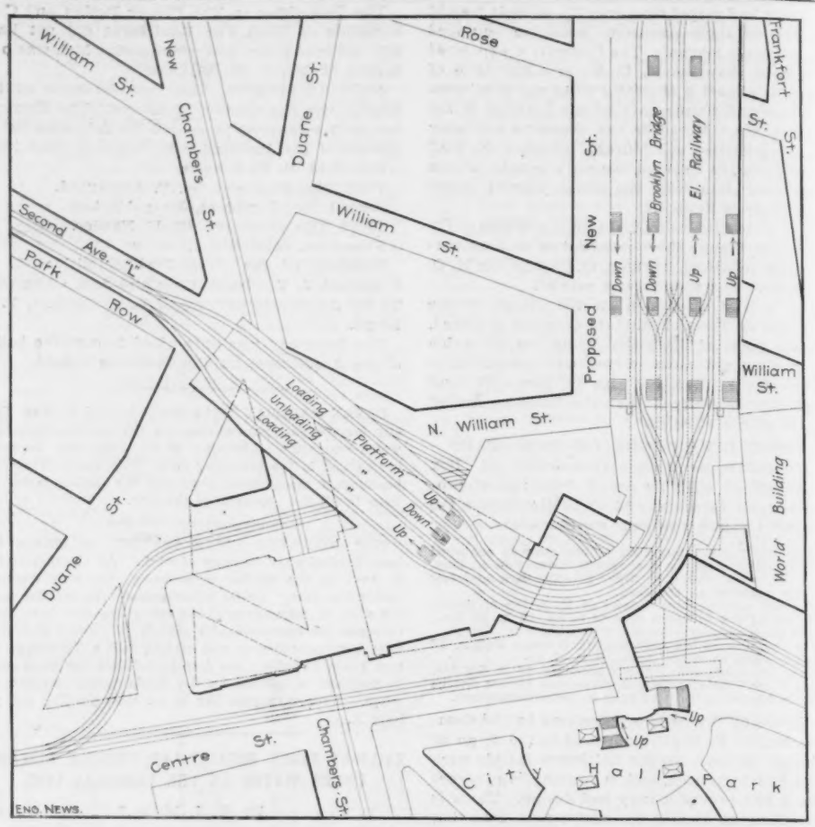


FIG. 1. PLAN OF THIRD LEVEL OF THE BROOKLYN BRIDGE TERMINAL STATION.

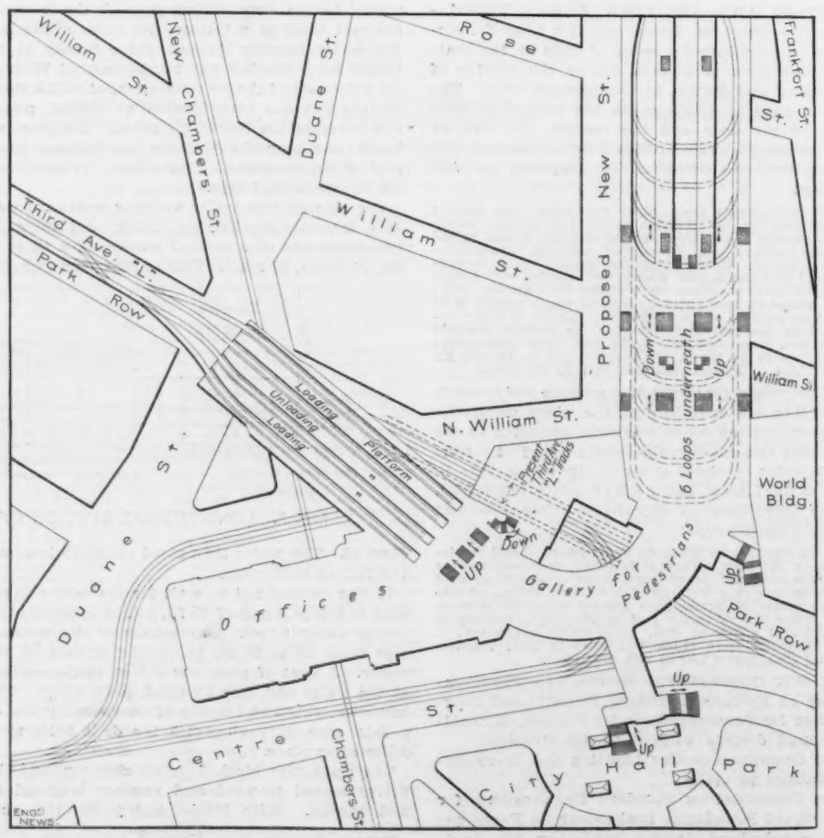


FIG. 2. PLAN OF FIRST AND SECOND LEVELS OF THE BROOKLYN BRIDGE TERMINAL STATION.